New Scientist

WEEKLY 23 October 2021

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Covid-19 daily update

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newscientist.com/coronavirus-latest

Podcast

Weekly

As cuts to welfare benefits in the UK are set to push thousands more children below the poverty line, we learn about the raft of health issues linked to child poverty. Meanwhile, bizarre signals are coming from an unknown object at the centre of the galaxy, and William Shatner has headed to space. The team also learns how sea cucumbers survive extreme environments and hears about a tropical fruit that could help us fight climate change.

newscientist.com/nspod

FELIX KUNZE/BLUE ORIGIN

To boldly go William Shatner headed to space with Blue Origin

ROIE GALITZ/WILDLIFE PHOTOGRAPHER OF THE YEAR

Tucking in A lion cub caught feasting on an African elephant carcass

Video

Wildlife Photographer of the Year

Five photographers tell the stories behind their award-winning images from this year's Wildlife Photographer of the Year competition at the Natural History Museum in London. For the latest science news, inventions and explainers, subscribe to our channel.

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Newsletter

Health Check

Sign up for our health reporter Clare Wilson's weekly newsletter all about health and fitness. In a recent edition, Clare asks whether we should be following doctors' orders without question, especially if the doctors disagree among themselves.

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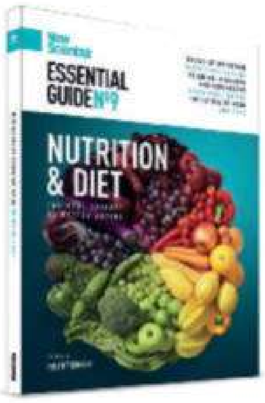
Newsletter

> "We are no longer expected to accept medical advice without question"



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Let's make this a good COP

The world has another chance to confront the climate emergency in Glasgow

IN JUST over a week, the doors will open in Glasgow, UK, on what is arguably one of the most consequential international summits in history. Yet for many people, it remains unclear why COP26, the 26th UN-sponsored "conference of the parties" on climate change, is so crucial. What would a good outcome even be?

It doesn't help that the UK, the host and diplomatic leader of the summit, which begins on 31 October, seems so muddled in its approach. Its long-delayed announcement this week of major green policies (see page 9) was welcome, but has been tarnished by political infighting over funding that raises old canards pitting the economy against the climate.

The president of COP26, Alok Sharma, has repeatedly said that its goal is to "keep 1.5°C alive", a reference to the toughest of the 2015 Paris Agreement's targets on checking global warming. Perhaps a first step towards public clarity in Glasgow would be to get the politicians to agree unambiguously with what the science says: that to avoid the worst of climate change, limiting warming this century to 1.5°C must be the goal, rather than the current messy twin target of 1.5°C (ideally) and "well below" 2°C (otherwise).

> "Pessimism is the last thing we need right now: COP26 shows the world is at least talking"

There are many more metrics that could be used to judge a "good" COP (see page 36): from agreeing a timetable for phasing out fossil fuels, to thrashing out details of a global carbon-trading scheme, to accelerating the process by which nations come up with new, improved emissions-reducing plans.

What is abundantly clear is that the cuts pledged by countries in the past year in time for Glasgow, as required by the Paris Agreement, leave us far from the 45 per cent reduction in emissions needed by 2030 to hit a 1.5°C path. In fact, they would equate to a 16 per cent rise in emissions.

Faced with the enormity of such figures, it is easy to be downbeat about securing a "good" outcome at the summit. But pessimism is the last thing we need (see page 25). COP26 shows that the world is at least talking. Perhaps the best, intangible outcome that can be hoped for is a renewed focus on humanity's common purpose and ability to solve this crisis of its own making by working together. ▮

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CHRIS RATCLIFFE/BLOOMBERG VIA GETTY IMAGES

Engineers training to install heat pumps in Slough, UK

Energy

Priming the heat pump

The UK government's plan to shift England and Wales away from gas boilers has received mixed reviews, reports **Adam Vaughan**

HOUSEHOLDS in England and Wales will be offered a £5000 government grant from April 2022 to buy low-carbon heating systems, as the UK government takes a major first step to ending the country's reliance on fossil fuels for keeping warm. The government is also planning to ban the sale of new gas boilers from 2035.

Gas boilers are used in about 86 per cent of UK homes, meaning heating and hot water for homes account for more than a fifth of the nation's carbon emissions. The boilers also account for a growing share of air pollution in towns and cities. Under the long-delayed Heat and Buildings Strategy, one of the decarbonisation strategies planned to help the UK achieve net-zero emissions, people will be encouraged to shift to heat pumps, which provide heating and hot water by using electricity to draw heat from the ground, air and other sources.

The new grants will effectively halve the typical £10,000 cost of an installed air-source heat pump, bringing it closer in line with gas boilers, which usually cost less than £3000 to be installed.

A total of £450 million has been allocated for the new grants over three years, enough for 90,000 homes. About 67,000 heat pumps are expected to be sold this year, but the government has a target of 600,000 installed each year in homes and buildings by 2028 to help meet its climate change targets.

"There's some really good stuff [in the strategy]," says Chris Venables at Green Alliance, a UK-based think tank. The £450 million for grants is larger than expected, he says, with £100 million previously mooted. The Confederation of British Industry, which represents UK businesses, welcomed the grants, which it said would "get the ball rolling when it comes to decarbonising homes".

However, Jan Rosenow at the non-profit Regulatory Assistance Project says the funding is too low. "Given that the target is to install 600,000 heat pumps per year, this is clearly not enough," he says.

Mike Childs at Friends of the Earth also called for more funding: "Investment will drive down the cost of heat pumps, and technical innovation plus skills training is a part of this, but so is scale. These grants will only incentivise the best-off households."

The government said it would work with industry to cut the costs of installing heat pumps by as much as 50 per cent by 2025. One UK company, Octopus Energy, has built a £10 million research and development centre near London, which it says could rapidly reduce the price of the technology.

But ministers deferred a crucial decision on a key way to make heat pumps cheaper by shifting the costs of environmental and social policies off electricity bills and on to gas bills. Such policies account for about a quarter of a home's electricity bill.

Instead, the UK's Department for Business, Energy and Industrial Strategy said in a statement: "Ministers want to reduce the price of electricity over the next decade by shifting levies away from electricity bills." But the decision – a potentially controversial one, as gas prices are already high due to the current energy crisis – will now wait until 2022.

Overall, the Heat and Buildings Strategy offers £3.9 billion of funding for decarbonising the UK's buildings, from social housing to the public sector. Venables says the money appears to be new, rather than recycled from past announcements.

There is one big omission in the plans. "The thing that seems to be missing is energy efficiency, insulation, draught-proofing and so on. That is a very quick win," says Simon Cran-McGreehin at the Energy and Climate Intelligence Unit in the UK. ▮

Coronavirus

Covid-19 still rife in Iran

An analysis of covid-19 infections among Iranian people casts further doubt on the idea that herd immunity can be achieved without vaccination, reports **Catherine Shaffer**

AFP VIA GETTY IMAGES

A student waiting to receive a covid-19 vaccine in Iran's capital Tehran

NEARLY everyone in Iran has been infected by the coronavirus at some point during the covid-19 pandemic, and some have caught the virus more than once, but the country still hasn't achieved herd immunity. Instead, Iran is seeing a punishing new wave of deaths driven by the delta variant.

Iran was one of the first countries after China to be hit by the pandemic, and it had a slow start to its vaccine roll-out. By July 2021, only about 3 per cent of the population was fully vaccinated against the coronavirus, according to Mahan Ghafari at the University of Oxford, although information from Johns Hopkins University in Maryland shows that proportion has now risen to about 23 per cent.

The Council on Foreign Relations, a US think tank, has called Iran's covid-19 mitigation measures "halting and ineffective", and said the country's response has been hampered by mixed messages from authorities.

Understanding the effects of covid-19 in Iran has been made more difficult by limited official data. Iran's Ministry of Health and Medical Education stopped releasing province-level data on confirmed cases and deaths in March 2020. Ghafari also says that low and middle-income countries are more likely to under-report cases and deaths due to a lack of health infrastructure and testing capacity.

To get round the shortfall in information, Ghafari and his colleagues analysed figures from Iran's National Organization for Civil Registration (NOCR) on how many deaths there were from all causes in the first nine months of 2020. They compared these with historical data to see how many more deaths there were than usual. The researchers used this excess deaths figure as a proxy to estimate the number of covid-19 deaths and population-level exposure to the virus – an approach that has proved accurate in the UK and South Africa.

The NOCR began releasing past weekly data stratified by age group in August, which allowed the researchers to reconstruct the dynamics of the pandemic in Iran from January 2020 through to September 2021.

They calculated how many people in each province had contracted covid-19 using known global figures on the percentage of infected people who die, known as the infection fatality rate (IFR) for each age group. Dividing the number of excess deaths by the IFR gives an estimate for the number of infections, and allows you to tell what proportion of the population is infected, also known as the viral attack rate.

The analysis showed that the total infected population was probably very high in many provinces. Eleven of them had rates over 100 per cent as of 17 September. The highest rates were seen in Sistan and Baluchestan province, which had an estimated attack rate of 259 per cent (medRxiv, doi.org/g2sn). If accurate, that would mean most people have had the virus twice and some for a third time. The researchers conclude that herd immunity through natural infection hasn't been attained in Iran in spite of widespread exposure to the SARS-CoV-2 virus, probably because of immunity waning over time, susceptibility to new variants of concern like delta or a combination of the two.

Firefighters disinfecting a street in Tehran

ABEDIN TAHERKENAREH/EPA-EFE/SHUTTERSTOCK

Mark Loeb at McMaster University in Canada says studies using direct measurements of infections are needed to conclusively determine the attack rate of the virus for a given population. However, he finds the study's conclusions plausible. "Overall, what's happening globally is that it certainly does appear that antibodies wane and there's not this point where, miraculously, herd immunity or herd effect is achieved," he says.

Loeb says he isn't aware of any pathogens for which herd immunity has been reached without vaccination. "By far the safest and most effective way to achieve herd immunity is through vaccination," he says.

The first strong indication that herd immunity against covid-19 can't be achieved without vaccination came from Manaus in Brazil. In October 2020, a study of blood donors there showed that 76 per cent of the population had been infected with the coronavirus, which was above the theoretical herd immunity threshold of 67 per cent for that

> "There is no country so far, 19 months into the pandemic, that has reached herd immunity"

community. That threshold is based on limiting the average number of other people an infected person is likely to go on to infect – the R number – to three. In December and January, Manaus saw an alarming surge in cases, hospitalisations and deaths, which was attributed to the highly transmissible gamma variant.

Evidence is piling up that the immunity conferred by infection wanes. A recent study of SARS-CoV-2 and related coronaviruses found that reinfection by SARS-CoV-2 occurred in about 16 months, less than half the time it takes for endemic "common cold" coronaviruses. And a study from India found a covid-19 reinfection rate of 27 per cent during the surge caused by the delta variant earlier this year (*Science*, doi.org/gm47sd).

David Fisman at the University of Toronto in Canada says, "Iran is a big and complicated place and I think the work [these researchers] have done has substantial face validity." However, he says the study's conclusions rest on two big assumptions: that all excess mortality is due to covid-19, and that the IFR estimates can be applied to Iran. He says if the IFR values aren't the same there, because of overwhelmed health systems or a new, deadlier viral variant, the calculated attack rate would then also be inaccurate.

The analysis is consistent with previous studies showing that immunity to covid-19 fades and new variants aren't stopped as effectively by immune defences, says Deepti Gurdasani at Queen Mary University of London. "There is no country so far, 19 months into the pandemic, that has reached herd immunity. And by that I mean, the point at which you lift all restrictions and the pandemic will actually die out because there's nobody left to infect." ▮

Artificial intelligence

Largest ever AI suggests limits to scaling up

Matthew Sparkes

MICROSOFT and chip maker Nvidia have created a vast artificial intelligence that can mimic human language more convincingly than ever before. But the cost and time involved in creating the neural network has called into question whether such AIs can continue to scale up.

The new neural network, known as the Megatron-Turing Natural Language Generation (MT-NLG), has 530 billion parameters, more than tripling the scale of OpenAI's groundbreaking GPT-3 neural network that was considered the state of the art until now. This progress required more than a month of supercomputer access and 4480 high-power and expensive graphics cards, which are commonly used to run high-end neural networks.

When OpenAI released GPT-3 last year it surprised researchers with its ability to generate fluent streams of text. It had used 175 billion parameters – allocated slots of data within a computer that replicate the synapses between neurons in the human brain – and consumed vast amounts of text from which to learn language patterns.

Microsoft and Nvidia, which released details of the AI in a blogpost, tested MT-NLG on a range of language tasks and found it could beat GPT-3, but not by much. On one benchmark, where an AI has to predict the end of a sentence, GPT-3 scored an accuracy of up to 86.4 per cent, while the new AI reached 87.2 per cent.

530 bn

Number of parameters that make up the new AI

This improved ability doesn't come cheap. "It costs effectively millions of dollars to train one of these models," says Bryan Catanzaro at Nvidia, as the computational resources needed to train it grow quickly.

MT-NLG was trained using Nvidia's Selene supercomputer, which is made up of 560 powerful servers, each equipped with eight A100 80 gigabyte Tensor Core graphical processing units (GPUs). Each of those 4480 graphics cards – designed to run computer games, but also extremely capable at churning through vast amounts of data while training AIs – currently costs thousands of pounds when bought commercially.

Nvidia's Selene supercomputer is a vast machine

NVIDIA

Even running the neural network once it is trained requires 40 of those GPUs, and each query takes between 1 and 2 seconds to process. This constant stretching of scale means that AI research is now, to a certain extent, an engineering problem of efficiently splitting up the problem and distributing it over vast amounts of hardware.

Catanzaro says that scale has been the dominant force in machine learning for decades. "It's definitely true that better algorithms help, and it's 100 per cent true that more data and better data absolutely helps, but I think that computing scale absolutely has been the driving force in a lot of progress," he says.

Many researchers are reluctant to rely on scaling-up alone as they want a more elegant solution, says Catanzaro, but the results speak for themselves. Although the benchmark measurements reflect small improvements, there are thought to be significant steps up in the way the bigger AIs reason and extract nuanced information, which perhaps isn't captured by ageing benchmarks, he says.

Samuel Bowman at New York University says that current benchmarks for assessing the quality of language processing AIs are nearing the end of their useful life. Researchers are seeking new metrics that can be used to assess the quality of language and even reasoning, he says, but that isn't made simpler by the rapid rate of progress in AI.

Those same researchers are also "nervously waiting to find out" if scale can continue to bring improvements or whether it will hit a ceiling, he says, as the cost of research in the field grows rapidly. ▮

Fertility

'Abnormal' IVF embryos can actually become healthy babies

Alice Klein

EMBRYOS that are often discarded by IVF clinics because they contain some seemingly abnormal cells are just as likely to develop into healthy babies as embryos with no chromosomal abnormalities, two new studies show. The finding means that many people trying to conceive with IVF will have more embryos to choose from.

To select the most viable embryos for implantation, IVF clinics visually assess their shape and often do genetic tests to find those with chromosomal abnormalities that are unlikely to survive. There is controversy over what to do with those containing just a small portion of cells with chromosomal abnormalities, known as mosaic embryos.

About 1 in 4 embryos made via IVF are found to be mosaic. These are often discarded or used as last-ditch options because of the perceived risk that they will miscarry or develop into babies with chromosomal conditions. But two studies presented at the annual meeting of the American Society for Reproductive Medicine on 20 October in Baltimore, Maryland, suggest these concerns are unfounded.

In the first study, Andria Besser at New York University Langone Fertility Center and her colleagues monitored the pregnancies of 35 people who had been implanted with mosaic embryos. Testing at the end of the first trimester showed that none of their fetuses had chromosomal abnormalities.

In the second study, Antonio Capalbo at reproductive genetic testing firm Igenomix compared pregnancy outcomes for 484 chromosomally normal embryos, 282 low-level mosaic embryos and 131 moderate-level mosaic embryos made via IVF. Mosaicism was classified as low level if 20 to 30 per cent of cells had abnormal numbers of chromosomes and moderate if 30 to 50 per cent did.

Both types of mosaic embryos had the same chance of implanting as chromosomally normal embryos and had the same chance – about 42 per cent – of leading to the successful births of babies. Genetic testing of the newborns found they had no chromosomal abnormalities, regardless of what kind of embryo they came from.

An embryo being selected for IVF implantation

ZEPHYR/SCIENCE PHOTO LIBRARY

One possible explanation is that mosaic embryos may have ways of removing abnormal cells as they develop. Another, which both Besser and Capalbo believe is more likely, is that difficulties with testing lead to many embryos being falsely identified as mosaic. Testing involves sampling tiny amounts of DNA from the layer of cells surrounding the embryo, which are hard to analyse and may not reflect the embryo's chromosomal status.

"But in any case, there don't seem to be any negative outcomes associated with the transfer of these embryos," says Capalbo.

This new understanding could spare people having IVF from worry and heartache, says Capalbo. Surveys have found that two-thirds of IVF patients who only have mosaic embryos decide not to use them, probably because of the perceived risks, and more than a third of IVF clinics in the US wouldn't implant such embryos. ▮

Astronomy

New Arid meteor shower delights star gazers

ASTRONOMERS have spotted a new meteor shower in the night skies of the southern hemisphere. The flurries of shooting stars occurred as Earth passed through streams of dusty material scattered across space by the comet 15P/Finlay.

Scientists have been routinely observing 15P/Finlay since it was discovered in 1886. In recent years, a number of independent analyses indicated that our planet would, in 2021, sweep through dense dust clouds left by the comet as it drifted through the inner solar system in 1995, 2008 and 2014. No one knew for certain, though, if the predictions would translate into visible meteors.

To find out, observers across South America – which was well-placed to see the meteors – were put on alert as the nights of anticipated activity approached, in late September and early October. Some researchers even deployed specialist meteor cameras to remote locations in Chile.

The fact that multiple groups were able to successfully observe the meteors, at the predicted times, has thrilled meteor scientists. "I've been working on this topic for 20 years, [this is] the first time I've seen the birth of a new meteor shower," says Jérémie Vaubaillon at the Paris Observatory, one of the researchers who made predictions about the meteor activity.

Researchers haven't yet calculated if the Arids will appear again in the future, but the 2021 event will have given astronomers valuable data to pore over.

> "I've been working on this for 20 years, this is the first time I've seen the birth of a new meteor shower"

Ye Quanzhi at the University of Maryland, who also modelled the dust streams from comet 15P/Finlay, likens the meteors to sample-return missions – where instead of sending a spacecraft to collect samples, they come to us.

"Comets are a loose collection of dust and ice, so by studying the meteoroids as they enter Earth's atmosphere we learn something about the building blocks of the comets," he says. ▮

Will Gater

Geology

Asteroid impact in vivid detail

An impaled turtle is among the latest finds from a geological site claimed to document the day a space rock slammed into Earth 66 million years ago, reports **Bas den Hond**

THE Chicxulub asteroid that jolted our planet 66 million years ago is widely thought to be responsible for wiping out the dinosaurs and many other species. Now, we might be seeing its effects on individual animals too.

A remarkable but controversial geological site seems to show how the asteroid caused the death of a turtle – which became impaled by a branch as the wave of destruction from the impact swept across the planet.

What's more, the evidence suggests that this happened during the northern hemisphere's spring or summer.

The findings come from excavations at the Tanis site – in the Hell Creek Formation of North Dakota – and were presented last week by Robert DePalma and Riley Wehr at the annual meeting of the Geological Society of America in Portland, Oregon.

As DePalma told it, the turtle that his team found led a charmed life before its untimely end. There is evidence of bite marks on its shell, probably made by some species of crocodile that tried and failed to catch it. It had dodged predators and other dangers for five years – its estimated age at death – before the asteroid hit.

"First, it would have experienced an odd seismic jolt, some minutes after the impact," DePalma told the conference. "And then it would have seen tiny, red-hot glass beads [in the sky] as the ejecta would have started to come in from the Chicxulub site. Then, the surge rushed up, about 10.5 metres in depth. At that point, he or she got impaled by a branch. So it was a very bad day for the turtle."

The manner of the turtle's death confirms that the Tanis site preserves evidence of a violent natural disaster, said DePalma, who is studying for a PhD at the University of Manchester, UK.

ROBERT DEPALMA

Fossil fish and other organisms that died at the Tanis site 66 million years ago

In 2019, he and his colleagues published the first description of the Tanis site, arguing that it gives a snapshot of life on a river on the day of the impact. Back then, Tanis was an elevated region of sediment in the bend of a river near the coast of the Western Interior Seaway – a large inland sea that almost bisected what is now the US. The seismic reverberations of the impact, which occurred at a site in the south of the Gulf of Mexico, caused huge waves in the sea. These ran upriver, burying many creatures under mud.

To support this claim, the 2019 publication reported fossils of fish preserved in the Tanis mud with glassy spherules from the impact lodged in their gills. Now, the analysis of growth patterns in the bones of those fish leads DePalma and his colleagues to conclude that the asteroid hit during the period when fish grow fastest: spring and summer.

This, together with other indicators, such as fossils of mayflies and traces of insect larvae activity on leaves preserved at the site, led DePalma and his colleagues to conclude that the impact time was between late spring and the end of summer. This means it coincided with late autumn or winter for the southern hemisphere, which is important, DePalma told *New Scientist*.

"Ecologies are going to experience global scale or major hazards differently depending on the time of year," he says.

Knowing the season of a global impact makes it possible to investigate and explain differences between sites.

For any of this to be convincing, other geologists must accept that the Tanis site does indeed preserve evidence of impact day. Thomas Tobin at the University of Alabama wasn't 100 per cent convinced in 2019, and he says he is reserving judgement on the new findings until they appear in a peer-reviewed scientific journal. "They haven't published anything new yet, so I haven't seen anything that changes my previous opinion," he says. "I would certainly re-evaluate my views if and when further publications are available."

"First, the turtle would have felt a seismic jolt, then it would have seen red-hot glass beads in the sky"

Even if DePalma is right about the Tanis site, not everyone will agree that it clinches the argument about the extinction of all dinosaurs apart from their descendants, modern birds.

Fabien Condamine at the Montpellier Institute of Evolutionary Sciences in France recently described a decline in dinosaur diversity starting 10 million years before the asteroid impact. "Certainly, there were places where dinosaurs were in a 'good ecological status', like in Hell Creek," he says, but in most places they weren't faring so well.

DePalma thinks that the Tanis site shows that the fossils found so far worldwide aren't telling the whole story. He says it is only by gathering new data at sites like Tanis that we will really understand the nature of the dinosaur extinction. "This is a job for scientific investigation and not for looking at old data," he says. ▮

Environment

Clearing the air

Low emissions zones in cities really do reduce air pollution without pushing it up elsewhere, reports **Adam Vaughan**

MILLIONS more people in London will wake on 25 October to find themselves living in a clean air zone, designed to deter the most polluting cars, motorbikes and vans and reduce the health effects of exposure to air pollution.

The expansion of the city's Ultra Low Emission Zone (ULEZ) from the centre to the suburbs is a key part of mayor Sadiq Khan's battle to rein in areas with levels of nitrogen dioxide in breach of legal limits. "It is going to be the biggest scheme of its type in the world," says Shirley Rodrigues, London's deputy mayor. "These are big interventions. What's so powerful about them is they happen quickly and that they are sustainable interventions, not one-offs."

Such zones are starting to yield important data on their impact. Analysis of NO_2 levels in London's original ULEZ area, which is about 18 times smaller than the new one, found that they fell at four times the rate of sites in outer London between February 2017 and February 2020.

Gary Fuller at Imperial College London, who reviewed that analysis, says: "In terms of do low emissions zones work, there is a really strong evidence base that they do." He says there is evidence from elsewhere in Europe, too.

> "Clean air zones drive down air pollution, but they need to come with support for people and businesses"

German cities, for example, have seen reductions of up to 7 per cent for particulate matter pollution (PM10) and 4 per cent for NO_2.

Such information suggests that there is no dramatic change in air quality on the day they take effect, says Fuller, because the shift is gradual. Simply announcing the start date of a zone usually triggers "pre-compliance", in which people upgrade their cars to newer, cleaner ones years in advance. "The benefits start well before the charge starts," says Fuller.

MARTIN BOND/ALAMY

London's Ultra Low Emission Zone is expanding this week

That is how low emissions zones, also known as clean air zones, are designed to work: as a catalyst for change rather than through people paying fees to keep polluting (£12.50 per day in London for most vehicles). Rodrigues says more than 80 per cent of cars in the area meet the London ULEZ's emissions standards, which generally means diesels sold after 2015 and petrol models sold after 2005, and she expects that figure to rise.

Efforts to establish clean air zones in other pollution-soaked UK cities are lagging, though. "They've been far too delayed, far too slow," says Jenny Bates at campaign group Friends of the Earth. After losing a legal challenge about progress on air quality, the UK government said in 2015 that clean air zones would be introduced in five cities in England to tackle NO_2 pollution above legal limits, a goal that hasn't yet been met.

Too slow

Outside London, there are 21 local authorities in England that have either implemented or are planning nine clean air zones – several overlap more than one local authority – according to environmental law group ClientEarth. In March, Bath became the first English city outside London to implement a clean air zone, although it doesn't cover cars and motorbikes, only larger vehicles. The country's second biggest city, Birmingham, followed suit in June, but with a more ambitious scheme that covers all vehicles.

Andrea Lee at ClientEarth welcomes those schemes and others coming, such as one planned for Greater Manchester that she thinks will happen next year. However, she says, action is still slow. The UK government's 2017 NO_2 plan put the onus on local authorities to come up with their own schemes to clean up air pollution. Several cities used the covid-19 pandemic as justification for delaying a zone, while some, such as Southampton and Derby, have rejected the idea and are

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trying different measures such as greening public transport or improving traffic management.

"We said from the start the way the government set this process up was passing the buck to local authorities," says Lee. "We said it would lead to delays, and it has."

"The aspiration is zero carbon, zero pollution, so zero emissions zones are still being looked at"

To date, no local authority has been sanctioned by central government for failing to introduce a clean air zone.

Other parts of Europe are forging ahead with clean air zones. Dozens of German cities have one, as well as Brussels, Madrid and Paris. The focus is usually on reducing levels of NO_2 and particulate matter a few micrometres across. However, there have been setbacks. Madrid's zone started in 2018, and saw NO_2 levels drop by around a third in its first few months. But the standards for the zone are now being watered-down, following a series of court cases.

One surprising success from the existing zones in Germany and central London is that they seem to reduce pollution in surrounding areas, rebutting criticism that such schemes displace polluting cars to elsewhere. "There's no evidence that actually happens," says Fuller. The positive spillover effect is probably explained by cleaner vehicles bought for use inside the zone being driven outside it too, he says.

Lee says the possibility of displacement is actually an argument for more clean air zones, rather than just a scattered handful. "That's why the Greater Manchester local authorities are acting together," she says.

Schemes have also been criticised for hitting the poorest in society hardest. Fuller says that doesn't seem to be true: cars in the UK's poorest areas are on average only a year older than those owned in the most well-off areas, so there is no reason poorer people would be disproportionately charged for using older cars. Lee says protecting people on lower incomes is one reason the zones can't be the only policy in use: "Clean air zones are a key measure to drive down the illegal levels of air pollution, but we do think they need to be accompanied by support for people and businesses."

Bates says one idea is scrappage schemes for older, polluting cars. She suggests these shouldn't just offer an incentive towards a clean vehicle, but also even more attractive incentives for shifting from a private car to public transport or a car share. One UK trial, Coventry's "mobility credits" scheme, allows people with petrol cars made before 2006 and pre-2016 diesel ones to exchange their car for up to £3000 to pay for public transport, bike rentals, taxis and e-scooters.

7%
Clean air zones in German cities have seen pollution levels reduced by up to this much

£3000
Maximum amount offered by Coventry, UK, for people to swap their car for greener transport

2030
Brussels in Belgium aims to ban diesel cars by this date

£12.50
Daily fee for driving in London's Ultra Low Emission Zone

Improving standards

Beyond extending the area covered by clean air zones, a key step for the future will be tightening the emissions standards they impose in order to continue reducing air pollution. Modern petrol and diesel cars that can enter London and Birmingham's zones without a charge still produce air pollution, as do electric vehicles because of wear on brake pads, tyres and road surfaces, but there is currently no timetable for when tougher rules might be imposed. By contrast, Brussels's zone has weaker standards than London's, but is slated to ban all diesel cars by 2030.

Rodrigues says the focus for now in London is on expanding the ULEZ, not revising standards upwards. But she says: "The aspiration is zero carbon, zero pollution, so zero emissions zones are still being looked at."

In the meantime, the bar for clean air is being raised. On 22 September, the World Health Organization (WHO) issued new air pollution guidelines, cutting the recommended maximum level for annual exposure to NO_2 by 75 per cent.

Large areas across many cities still fail to meet the old WHO limits, let alone the new ones. The whole of London exceeds the new levels, and the expanded ULEZ won't help to meet them. Rodrigues says the new guidance has made her more determined to make sure the city's expanded ULEZ works well. "This is people's lives, people's daily lives being affected [by pollution]," she says. ■

An anti-pollution protest that took place in Madrid, Spain, in 2019

MARCOS DEL MAZO/LIGHTROCKET VIA GETTY IMAGES

Solar system

The Lucy spacecraft has set off on a journey to study Trojan asteroids

Leah Crane

NASA's latest mission to study the Trojan asteroids launched on 16 October from Cape Canaveral, Florida, aboard an Atlas V rocket. The Lucy spacecraft will be the first to visit them up close.

The Trojan asteroids circle the sun in two swarms that share Jupiter's orbit like a police escort for the planet, one moving ahead of Jupiter and the other just behind it. They are some of the most pristine relics from the early solar system, thought to be leftovers from the process that formed the outer planets.

"They're held there by the gravitational effect of Jupiter and the sun, so if you put an object there early in the solar system history, it [will be] stable forever," said mission leader Hal Levison at Southwest Research Institute in Texas during a press conference on 13 October. "These things really are the fossils of what planets form from."

SOUTHWEST RESEARCH INSTITUTE/NASA

Illustration of the Lucy probe passing one of the Trojan asteroids

Despite their importance, the asteroids' strange orbits mean that we have never studied them up close. To get there, Lucy will follow a complex trajectory over 12 years. First, it will make two fly-bys of Earth to build up momentum, which will toss it towards the leading swarm of asteroids.

On its way there, it will pass a non-Trojan asteroid in 2025 named (52246) Donaldjohanson after the discoverer of Lucy, a famous fossilised skeleton of a human ancestor for which the mission is named. Once the spacecraft reaches the leading swarm, it will examine four Trojan asteroids, one of which has its own moon.

Finally, Lucy will swoop past Earth again and visit a pair of asteroids in the trailing swarm in 2033. After that, if all goes well, it will keep flying back and forth between the two clouds of Trojans every six years until the solar-powered spacecraft deteriorates.

Lucy carries three scientific instruments. One will measure the heat coming off the asteroids to figure out their surface properties, while another will examine light bouncing off them to learn about their make-up. The third instrument is a camera that will take detailed colour images.

> "These asteroids in Jupiter's orbit really are the fossils of what planets form from"

The spacecraft will visit all three main kinds of Trojans, which are defined by the colour and reflectivity of their surfaces. The three types may indicate different compositions or birthplaces of these asteroids, which could help us understand where in the solar system they formed and how they were tossed around as the giant planets migrated to their current locations.

"If you want to understand what this population is telling us about how the planets formed, you need to understand that diversity, and that is what Lucy is intended to do," said Levison. ▮

Military technology

Robot dog armed with a sniper rifle goes on display

THE US military may be getting a dog-like quadruped robot armed with a sniper rifle. The robot, developed by Ghost Robotics of Philadelphia, is a new version of its Vision series of legged robots.

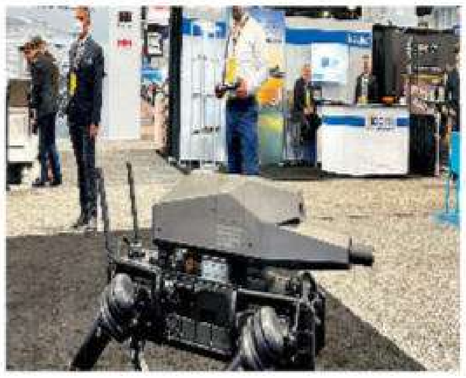
The US Air Force is testing an unarmed version of these robots for the Tyndall Air Force Base in Florida. Ghost Robotics displayed the armed version at the annual meeting of the Association of the United States Army in Washington DC last week.

Ghost Robotics has been developing quadruped robots since 2015 and has previously displayed versions fitted with additions including arms for bomb disposal and a disruptor, a shotgun-like device for disabling bombs.

The robots are highly mobile, able to cross rugged terrain that might be difficult for wheeled and tracked machines, and can operate with a high degree of autonomy.

However, Ghost Robotics CEO Jiren Parikh is quick to dismiss any ideas that the sniper rifle is an autonomous weapon system.

"It is fully controlled by a remote operator," says Parikh. "There is a human controlling the weapon, there is no autonomy or AI."


GHOST ROBOTICS

The robot is fitted with a powerful 6.5 millimetre sniper rifle, controlled by a human operator

He says that the robot was chosen by customers for its ability to move in difficult terrain, allowing it to take up a suitable firing position for sniper shots. This applies equally outdoors and in urban settings where, for example, it can climb stairs. Meanwhile, the operator can stay concealed out of the line of fire.

Parikh notes that while there were numerous uncrewed tracked and wheeled vehicles with weapons at the same show, his has been singled out. He suggests that it triggers an emotional reaction as it looks like an animal, and because of decades of science fiction movies about dangerous robots. ▮

David Hambling

WE NEED
LESS
Statkraft

Archaeology

Ancient faeces show Iron Age salt miners ate blue cheese

Carissa Wong

FUNGI found in faeces from Iron Age people who worked in salt mines in what is now Austria suggest that people were eating blue cheese and beer at least 2700 years ago.

The ancient faeces have "entrapped information like a time capsule", says Frank Maixner at Eurac Research in Italy, adding that this is the earliest evidence for blue cheese. Maixner and his colleagues discovered four samples of ancient faeces in the salt mines in Hallstatt, Austria. They sequenced the preserved genomes of the microbes in them. One sample contained the mould species *Penicillium roqueforti*, which is used to create blue cheese today (*Current Biology*, doi.org/g2m7).

ANWORA/NHMW

Ancient faeces found in a salt mine in Hallstatt, Austria

Maixner says environmental contamination is possible, but all faeces were found in a similar location within the mine and only one sample contained *P. roqueforti*, which makes the team confident the blue cheese was consumed. The team found wooden containers in the mines, which may have been used as cheese strainers, although analysis of any fat molecules in the strainers is needed to confirm this.

The genetic analysis also revealed a domesticated strain of the yeast *Saccharomyces cerevisiae*, which is used to make beer, but not other yeast species, suggesting the beer was "probably more like craft beers, which are more turbid. It would be more of a pale ale," says Maixner. He adds that the constant temperature of 8°C in the mines is ideal for beer production.

Space

Venus's surface may always have been too hot for oceans

Jonathan O'Callaghan

VENUS might never have had the conditions necessary for water to exist on its surface, meaning the planet wouldn't have been habitable as once thought.

Today, Venus is a hellish world, with temperatures on its surface hot enough to melt lead. Yet the presence of water vapour in its thick atmosphere, coupled with surface features known as tesserae that look like ancient continents, suggest it could once have supported oceans and maybe life billions of years ago. Three new Venus spacecraft, two from NASA and one from the European Space Agency (ESA), were recently selected for launch in the next decade, partly to investigate this possibility.

Martin Turbet at the University of Geneva in Switzerland and his colleagues, however, present a less rosy picture. Their climate modelling suggests that the planet was never cool enough for the water vapour to condense out of its atmosphere and form liquid water on the ground. "Venus probably never formed oceans," says Turbet.

Previous modelling of Venus presumed that the planet started with liquid water, which then evaporated as a runaway greenhouse effect took place. Turbet, however, says it is more likely that Venus started out as a "steam" world, with its vapour already trapped in the atmosphere.

"Venus may have started as a 'steam' world, with vapour already trapped in its atmosphere"

In such a scenario, the formation of clouds on the cooled, night-time side of Venus would have trapped heat on the planet, preventing temperatures from dropping far enough for rain to fall on Venus's surface.

"They will create some precipitation, but it will never reach the ground because it will get re-evaporated while it's falling," says Turbet (*Nature*, doi.org/g2pw).

If correct, the findings may suggest that the window for planets to become habitable is even more narrow than astronomers had thought.

The researchers found that Earth was only able to condense water early in its history because the sun was about 25 per cent dimmer, seemingly solving a problem known as the faint young sun paradox where Earth was thought to have been too cold to support liquid water. Had it formed today, our planet might well have been a "steam Earth", like Venus.

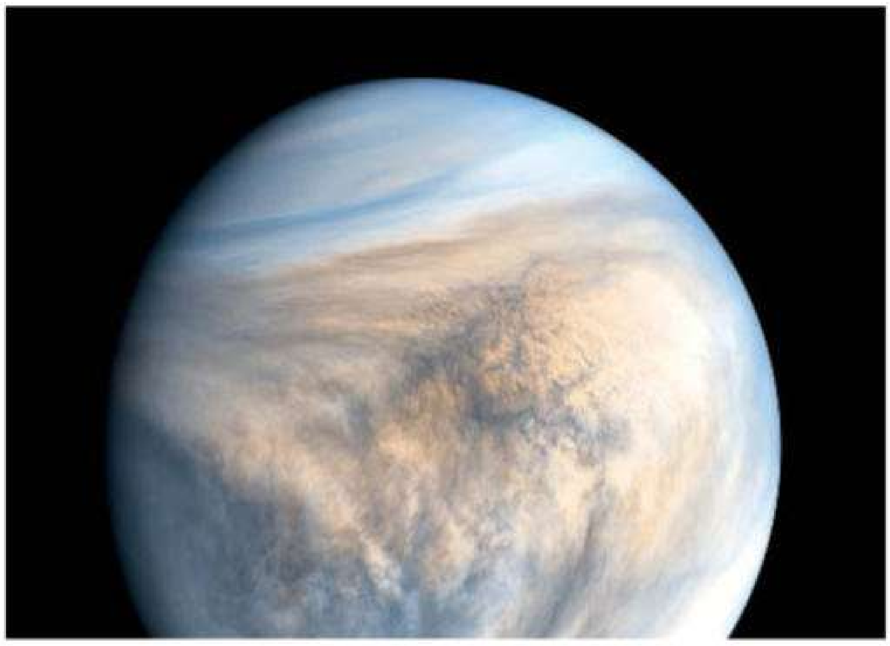
Michael Way at the NASA Goddard Institute for Space Studies in New York, who has conducted previous climate studies of Venus, says that while the results describe one of the possibilities for the evolution of Venus, they don't close the case just yet.

"I do not think this ends the debate on whether Venus ever condensed water on its surface," he says. "All of these models have limitations. It is necessary for additional models to replicate these results."

To find out for certain, we will need to study the surface of Venus directly to look for evidence of water, something that NASA and ESA's upcoming missions plan to do.

Colin Wilson at the University of Oxford, a deputy lead scientist on ESA's EnVision spacecraft that is set to launch in the 2030s, says the presence of granite-like rock that makes up Earth's continents could be such evidence.

"Our current understanding is you can't create those widespread rocks without large amounts of liquid water on the surface," he says. "If we don't discover it, that leaves the question somewhat open."


JAXA/ISAS/DARTS/KEVIN M. GILL

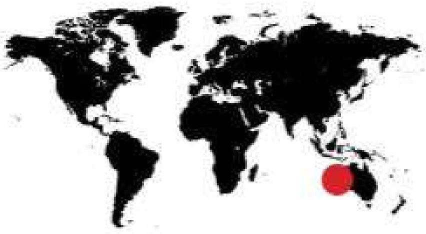
Venus may never have been cool enough for oceans or life to form

Conservation

Odditiesunder threat

Some of evolution's most unusual species are now at risk

Chen Ly

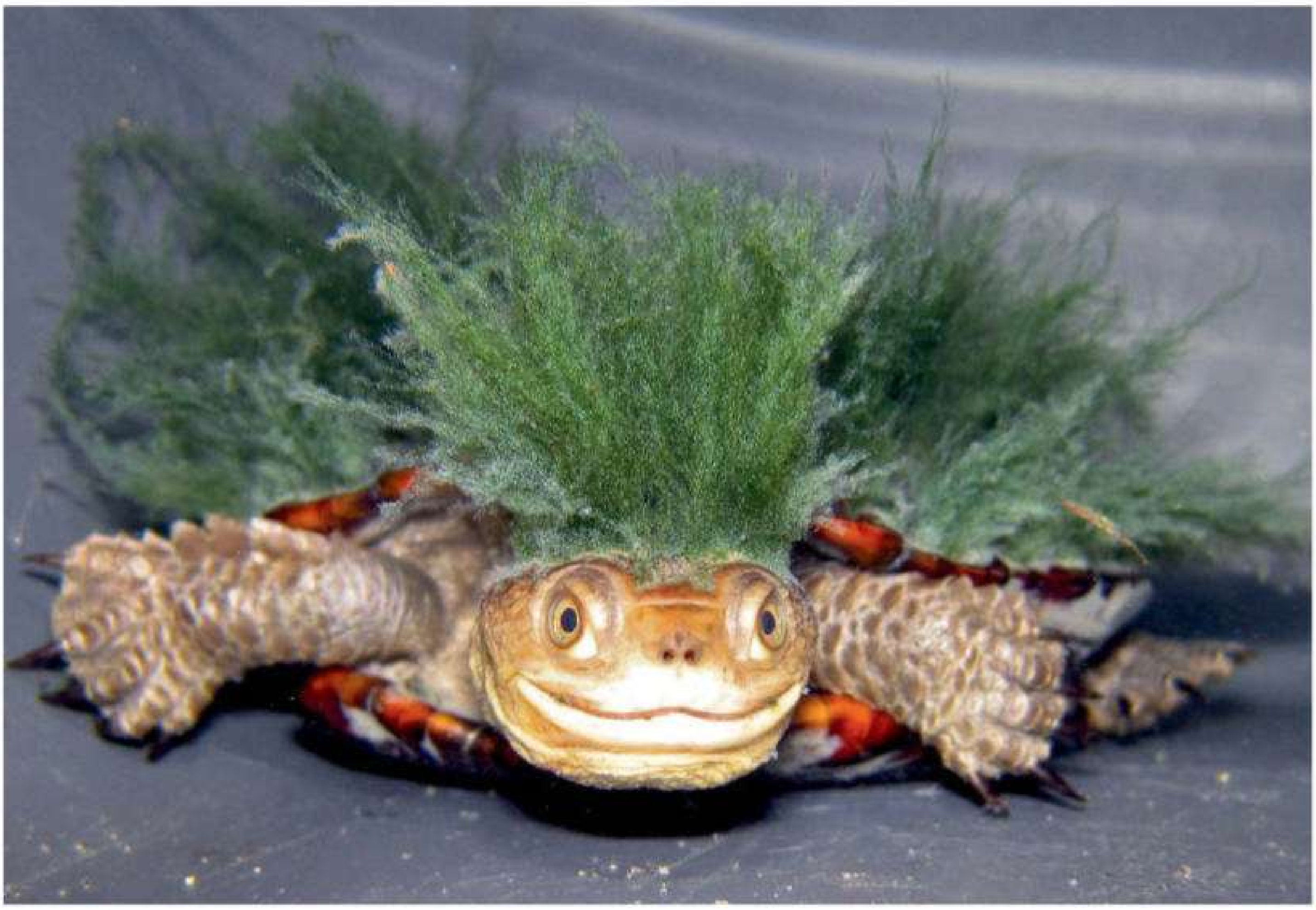


THIS curious creature is a western swamp turtle (*Pseudemydura umbrina*), an Australian species that occasionally wears a coat of algae.

But its green outfit isn't what makes this turtle so special: it is the fact that it sits on an evolutionary branch that diverged from other turtles some 90 million years ago.

The western swamp turtle and many other evolutionarily unique animals face a disproportionately high threat from human activity, according to an analysis of over 30,000 species of birds, mammals and reptiles by Gopal Murali at Ben-Gurion University of the Negev in Israel and his colleagues.

The study found that such species often live on islands in the tropics (*Science Advances*, doi.org/g2rn). "Our findings highlight the urgent need for conservation plans to safeguard the regions that hold the world's unique and isolated species," says Murali. ▮



GERALD KUCHLING

Astronomy

Odd space signal may be shape-shifting cloud

AROUND a star about 2300 light years away, something strange is happening. An object is circling the star and blocking out light, but the size and shape of this entity appear to be always changing, and we don't know what it is.

Brian Powell at NASA's Goddard Space Flight Center in Maryland and his colleagues spotted an odd pattern in the light from a binary star system called TIC 400799224 using the Transiting Exoplanet Survey Satellite.

They found that about once every 19.8 days, something passed between the two stars and the satellite observatory, blocking out some starlight. But it didn't look the same each time.

The dimming varied from just a few per cent to about 25 per cent. The length of the eclipses were different too. Sometimes, they lasted up to two days, but on other occasions, when 19.8 days had passed and the researchers expected to see another dip in the light, nothing happened (arxiv.org/abs/2110.01019).

We have never seen anything quite like this. "Sometimes, the obscuring object is present, sometimes it's not, sometimes it's a lot larger than other times," says Powell. "That makes it particularly neat, because we don't see that behaviour in planets – they don't just change shape, or disappear sometimes."

Instead, the researchers suspect that something is regularly emitting huge clouds of dust, which could change shape and dissipate as they orbit one of the stars in the system.

To create the observed signals, whatever is making the dust must be putting out about 3 million kilograms of it every second.

If you removed dust from the dwarf planet Ceres in our own system at this rate, that tiny world would only last for about 8000 years. That may seem like a long time, but in astronomical terms it is extraordinarily quick, making it difficult for a single dust-emitting object to be responsible for the mysterious signal.

"We don't know what this object is, but it appears there's something getting smashed"

Instead, Powell says the most likely explanation is that two or more objects are repeatedly crashing together in orbit. "We just don't have a lot of clarity on what this object is, but it appears there's something getting smashed," he says. "We believe this is the result of collisions between potentially several large bodies."

Figuring out exactly what is getting pulverised will require more observations over many more 19.8-day periods. ▮

Leah Crane

WE NEED
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ELECTRIC VEHICLES
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Coronavirus

The spectre of long covid

The care situation for people with long covid in England is improving, but a winter spike in cases will put specialist clinics under new pressure, reports **Adam Vaughan**

THE number of people with long covid who get a successful referral to specialist clinics in England has fallen slightly, according to the first national figures on how healthcare capacity for the most debilitating cases is changing.

There are an estimated 706,000 people in the UK today with long covid symptoms severe enough to limit their daily activities, up by around 10 per cent on August. Some people fear numbers will rise further in winter as people mix more inside, stretching the capacity of the 89 long covid clinics around England. The other three UK nations have none.

Claire Hastie, who sits on the NHS England Long COVID Taskforce and set up the Long Covid Support group, says she has "massive" concerns over a new wave of long covid cases in coming months, including in children. "It's horrific what's going on in schools," she says, because a lack of mitigation measures and vaccination means a high risk of infection for children, and potentially long covid.

Statistics published last week show that 4846 people were successfully referred to a long covid clinic in August, a 3.6 per cent fall on the 5029 in July. Melissa Heightman, who runs a long covid clinic at University College Hospital, says: "In my opinion from the coal face, I think we are in a better place than we have been previously. Our waiting times are now starting to improve."

A spokesperson for the hospital's NHS Foundation Trust says the clinic is now receiving fewer referrals from beyond the five London boroughs it usually supports, which they believe is due to more long covid clinics, and greater capacity at them, across England. "Referral rates are reducing but we know there are still a lot of patients waiting," says Heightman, who was recently appointed a national adviser on long covid by NHS England.

Heightman says her focus in the coming months is on making sure long covid clinics don't fall prey to emergency pressures if there is another spike in acute covid infections. "Concerns going into winter for me are really just about maintaining the post-covid pathways, alongside all the other pressures," she says. "Whenever there's another wave of the pandemic and an increase in in-patient numbers, workforce can be diverted to that need. It's just about keeping everything going."

Hastie sees evidence that things are improving too. Long Covid Support's own surveys of patients found 73 per cent of respondents successfully being referred in August, up from 51 per cent in May.

There is no robust evidence on a treatment for long covid yet, but specialist clinics draw on a multidisciplinary team, from physios to doctors and psychologists, to help people with physical symptoms and the mental impacts.

The experiences of people seeking care for long covid have been mixed. Polina Sparks, who lives in Greater Manchester, found the referral process slow and found she was "going in circles" until she eventually visited a clinic in June – only to be discharged because its focus was on respiratory problems, which didn't apply to her symptoms. "The impact of that was quite devastating. You wait and you wait to see somebody," she says. But a visit to a clinic this month was "much more positive", she says.

> "Concerns going into winter for me are really just about maintaining the post-covid pathways"

Long covid clinic capacity appears to be uneven across England. Many NHS trusts that run clinics told *New Scientist* they can take about 20 new patients a week – these include the Tameside and Glossop Integrated Care NHS Foundation Trust and Rotherham Doncaster and South Humber NHS Foundation Trust.

However, several have much lower capacity, such as two per week at York and Scarborough Teaching Hospitals NHS Foundation Trust and three per week at Royal Surrey NHS Foundation Trust. Cambridge University Hospitals NHS Foundation Trust, by contrast, takes up to 30 per week.

Whether England's clinics will have capacity to cope with a winter wave of new long covid cases will depend on how common the condition is. The UK Office for National Statistics (ONS) has found that 11.7 per cent of people describe themselves as having long covid 12 weeks after a confirmed infection. But just 7.5 per cent of infected people say the condition is severe enough to curb their activities.

Crudely, that would imply a single day of UK cases – 38,520 positive on 12 October – could lead to nearly 3000 people with activity-limiting long covid. But different ways of measuring long covid yield different estimates of how many people have it. Another ONS approach, asking people if they have experienced any of 12 common symptoms continuously for at least 12 weeks from infection, suggests the figure is 3 per cent. A separate study published in March suggests 2.3 per cent after 12 weeks.

Whatever the true figure, Heightman says the care situation is improving – not because cases are declining, but because the capacity of long covid clinics is increasing. "Things are probably still not where we'd like them to be, but they are hugely better than they were about four months ago," she says. ■

DAVID STOCK

Melissa Heightman (left) speaking to a patient at the UCH long covid clinic

KUMAR SRISKANDAN/ALAMY

Animal behaviour

Penguins tell each other apart by sight and sound

SOME penguins match the calls of fellow penguins to their faces or other aspects of their appearance, making them the first birds besides crows known to have this ability.

African penguins (*Spheniscus demersus*, pictured) may have evolved this skill in order to improve communication in their coastal setting where background noise can be a problem, says Luigi Baciadonna at the University of Turin in Italy.

Baciadonna and his team worked with 10 adult penguins in captivity in a colony of 17 individuals at a park in central Italy. They placed the penguins in pairs. Each pair was put in a separate enclosure for about a minute before one of the two was herded out through a door. Twenty seconds later, the scientists played a recording of a penguin squawk from a speaker above the door.

Sometimes, the squawk was from the partner penguin that had just left the enclosure; sometimes, it was from a randomly chosen penguin from the same colony.

The penguin left in the enclosure always responded to the audio by looking at the door. But if the call came from a randomly chosen penguin, the tested penguin looked at the door more than twice as quickly as it did when the audio recording was from the penguin that had just passed through the door (*Proceedings of the Royal Society B*, doi.org/g2ps).

This behaviour indicates that the tested penguins weren't expecting to hear the randomly chosen penguin's call because it conflicted with their mental image of the penguin that had just exited, says Baciadonna. **Christa Lesté-Lasserre**

Diet

US appetite for junk food grows

ADULTS in the US have been eating more highly processed junk food over the past two decades.

Filippa Juul at New York University and her colleagues analysed data from a yearly survey carried out since 2001. Each year, the survey asks a nationally representative group of 5000 US adults to recall what they have eaten in the past 24 hours.

The researcher put foods into four groups based on the level of processing applied to them, from minimally processed foods, which include fruits, vegetables and parts of animals such as steak, to ultra-processed foods, such as ready meals, breakfast cereals and fries. They estimated the proportion of the total daily energy intake provided by the four groups.

The team found that ultra-processed foods made up 53 per cent of the daily energy intake of US adults in 2001, rising steadily to 57 per cent by 2018, the most recent year figures were available.

Although a causal link between eating highly processed food and weight gain was recently shown in the first study of its kind, "there aren't really policies that address this type of food as a group", says Juul. This is partly because, until now, recent trends in ultra-processed food consumption in the US were unclear.

The team also found that these foods are less commonly eaten in certain groups based on ethnicity and education level (*The American Journal of Clinical Nutrition*, doi.org/g2p2).

Both non-Hispanic white and non-Hispanic Black Americans eat more ultra-processed foods than Hispanic people, says Juul. When the team controlled for income, it found that "people with a college degree eat less ultra-processed foods than people with lower education levels", she says.
Carissa Wong

Medicine

Gender imbalance in stroke studies

CLINICAL trials to test stroke treatments don't include enough women, a disparity that could be hampering efforts to develop better care for affected people.

Cheryl Carcel at the George Institute for Global Health in Australia and her team analysed 281 stroke studies from around the world – each involving at least 100 participants – from 1990 to the beginning of 2020. In total, the studies involved close to 600,000 people.

They then compared the number of women enrolled in each study with how many women actually have a stroke in the region in which the study was conducted, predominantly the US, Asia or Europe.

They found that, on average, just 40.1 per cent of study participants were women, whereas globally 48 per cent of strokes were in women. The team also discovered that studies in Asia had the fewest women enrolled, just 37.5 per cent of the study participants on average (*Neurology*, doi.org/g225).

The researchers discovered that non-acute and rehabilitation stroke studies enrolled fewer women than those analysing acute stroke. Carcel says this may be because these kinds of studies typically last longer, which may deter women with caring responsibilities from taking part.
Jason Arunn Murugesu

BSIP/EDUCATION IMAGES/UNIVERSAL IMAGES GROUP/GETTY

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Really brief

JOHN DAVID CURLIS

Mass extinction led to shift in snake diet

Before dinosaurs were wiped out 66 million years ago in a mass extinction, snakes typically ate insects, an analysis suggests. But afterwards, they broadened their diets to include birds and mammals, perhaps because there was no longer competition from the dinosaurs (*PLoS Biology*, doi.org/gm4zj6).

US now leads world in mining bitcoin

Following a crackdown on cryptocurrency use in China, the US has become the world's largest bitcoin-mining nation, according to analysis by the University of Cambridge. Its share doubled from 16.8 per cent in April to 35.4 per cent at the end of August. Mining relies on power-hungry computers.

Scan can ID you via unique brain signal

Each of us has a distinct brain activity "fingerprint", and this can be spotted after someone lies in an MRI scanner for just 100 seconds. This identifying pattern of activity is known as the "connectome" because it shows how different brain regions are in sync (*Science Advances*, doi.org/g2rf).

Astronomy

Giant exoplanet shrugs off star death

A JUPITER-LIKE planet that survived the death of its star might have provided us with a preview of the far future of our solar system.

The planet, which is named MOA-2010-BLG-477Lb, was spotted in 2010, but now Joshua Blackman at the University of Tasmania in Australia and his colleagues in several other countries have confirmed that it orbits a white dwarf. This is the remnant left when a star like our sun runs out of fuel.

Jupiter-like planets have been spotted around white dwarfs before, but those were closer to their suns, suggesting a momentous change in position. This is the first time such a planet has been seen in its original orbit.

Astronomers first discovered the planet and its host star using a microlensing event. These occur when an object moves in front of a star and its gravitational field magnifies the light of the star.

Studying this change in light can reveal the characteristics of the foreground object. Analysis of a 2010 microlensing event identified a foreground star similar to our sun – MOA-2010-BLG-477L – with an accompanying planet, MOA-2010-BLG-477Lb.

From follow-up observations of this region between 2015 and 2018, the researchers realised that MOA-2010-BLG-477L must be a white dwarf, not a sun-like star as thought (*Nature*, doi.org/g2p9).

"This study is a snapshot into the future of the solar system," says Blackman, providing a greater insight into how Jupiter and other outer planets will fare after the death of our own sun. **Chen Ly**

Fossil fuels

FRANK HOENSCH/GETTY IMAGES

Net-zero path would reduce risk of spikes in energy prices

CONSUMERS would be cushioned against energy price shocks like the one affecting many countries today, if the world adopts policies that put it on track to net-zero emissions, says the global energy watchdog.

However, governments are a long way from that trajectory, says the International Energy Agency (IEA).

The Paris-based group's *World Energy Outlook* report warns that this year will see the second biggest annual rise in carbon dioxide emissions from energy, wiping out two-thirds of the CO_2 savings brought about by lockdowns and other restrictions last year.

Tim Gould at the IEA says the current energy price spikes, driven primarily by the soaring cost of gas, aren't caused by a transition to cleaner energy. In fact, the group's analysis suggests that renewables, energy efficiency and electric cars may hold the answer to protecting against a repeat of today's crisis.

The IEA modelled a price shock in 2030, where coal, gas and oil prices reached the highest levels they hit in each region between 2010 and 2020. It found it would be 30 per cent less costly for households in a scenario where the world is on a trajectory to net zero by 2050 than a scenario similar to the path we are currently on. **Adam Vaughan**

Health

Pill may cut diabetes risk for some women

HAVING polycystic ovary syndrome (PCOS) leaves women facing a higher than average risk of developing diabetes – now it seems taking the contraceptive pill could reduce that likelihood.

In PCOS, which affects about 1 in 10 women, the ovaries produce too much testosterone. Those affected are more likely to be overweight and have more body hair. They also have higher levels of insulin, a hormone that regulates blood sugar, and their cells are less sensitive to insulin, which together can lead to type 2 diabetes.

A team led by Wiebke Arlt at the University of Birmingham in the UK looked at nearly 200,000 people, about a third of whom had PCOS, with the rest being carefully matched for other factors such as weight and age.

On average, those with PCOS had nearly twice the risk of being recorded with type 2 diabetes or a "prediabetes" condition of high blood sugar than the control group during the next four years. But those with PCOS who were on the pill had about three-quarters of the risk of developing type 2 diabetes or prediabetes as those with PCOS who weren't on the pill (*Diabetes Care*, doi.org/g2qq).
Clare Wilson

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Jacob Aron gets stuck in a quantum loop in *Deathloop* p34

Comment

Time for the optimists

Doom-filled facts will never be enough to tackle global warming. Hope is more important than ever, writes climate scientist **Katharine Hayhoe**

CLIMATE change is no longer a future issue or a distant one. It is here now, intensifying extreme weather events, threatening food and water supplies and putting our health at risk. Headlines bombard us with an increasing litany of disasters, from coastlines flooding and ice sheets disintegrating to drought in Madagascar and wildfires across western North America.

Record numbers of us are worried about climate change – 66 per cent in the US where I live, 76 per cent in the UK and 84 per cent of young people across 10 different countries. However, the disconnect between now and the future we face grows starker every day. Only around 50 per cent of people in the US and UK believe climate change will have much of an effect on them personally, and even less think individuals can do anything to combat it.

It is no wonder the question I'm asked most often is: "What gives you hope?" We need hope, desperately, because if we believe it is too late, it will be.

The kind of hope we need – rational, stubborn hope – isn't about positive thinking, but it doesn't begin with imitating an ostrich, either. It starts by acknowledging just how serious climate change is and what is at risk: the future of civilisation as we know it. Recognising the overwhelming nature of this crisis can fill us with fear and anxiety, and we need to acknowledge these emotions as well.

MICHELLE D'URBANO

Here is where the turning point must occur. Will we allow fear to paralyse us or use it to galvanise us into action? Only one path leads to hope. The other ends in despair. It is only our actions that offer a chance of a better future. And when we realise the giant boulder of climate action isn't sitting at the bottom of an impossibly steep hill with only a few hands trying to push it up, but rather it is already at the top and rolling down the hill with millions of hands pushing it in the right direction, that gives us hope. It isn't going fast enough yet; but for each new hand that joins, it will go a little faster. As the Intergovernmental Panel on Climate Change says: "Every action matters... Every choice matters."

The most dangerous climate impacts can still be avoided. But the window for staving off the worst of these is closing fast. That is why it is past time to deploy the most important force we have: our voice. In the UK, less than half of people surveyed said they have discussed climate change in the past week. In the US, 67 per cent of people surveyed said they "rarely" or "never" bring up climate change in conversation. We may avoid these conversations because we don't want to get into yet another argument, we are tired of trying to guilt people into green living, or we are simply overwhelmed with doom-filled facts. And I agree: I avoid those conversations, too.

The most powerful conversations begin with our hearts, not our heads. Start with something that is important to you – and them. It could be a place or activity you love, a shared concern or career, the fact that you are both parents, birders, churchgoers or live in the same place. Connect the dots to show how warming is affecting your life, and theirs, today. Bring up practical solutions: from your lifestyle choices to sustainable agriculture to greening cities. Who wouldn't want to fly on an aeroplane powered by recycled cooking oil, hear about how solar energy is transforming the lives of women in sub-Saharan Africa, or just reduce their own food waste, especially if it would help ensure a safer world for all our children?

The world begins to change when individuals decide it can, and it should – and when we use our voices to call for action where we live, where we work, where we put our money and where we vote. Whoever you are, you are already the perfect person to advocate for climate action. Why? Because you are a human living on Earth. ▮

For more on tackling climate change, see pages 26 and 36

Katharine Hayhoe is author of *Saving Us: A climate scientist's case for hope and healing in a divided world*

No planet B

A carbon credit card Personal carbon allowances were once deemed to be too far ahead of the curve, but the time may finally be right for a revival, writes **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *This Book Could Save Your Life*. You can follow him @grahamlawton

Graham's week

What I'm reading
Rationality: What it is, why it seems scarce, why it matters *by Steven Pinker. I am interviewing him soon.*

What I'm watching
The second season of ITV's gripping police procedural Manhunt.

What I'm working on
Covid-19 bureaucracy so I can get into Finland.

I WILL be spending a lot of time in northern climes over the next few weeks, and I am preparing myself for a roller coaster of climate emotions. As I write, I am getting ready for a trip to Finland to report on some of the world's most advanced sustainable industries. I am expecting to be inspired by what I see.

Later this month, I will arrive in Glasgow, UK, to cover the first week of the COP26 climate negotiations. The constant warnings that leaders are set to fail, yet again, to commit to the actions needed to avoid catastrophic warming have me worried that my optimism may not last.

You can read a comprehensive preview of COP26 on page 36 of this magazine, and I will keep my Finnish powders dry for later editions (though here's a spoiler: wooden satellites!). But the two trips already promise to be a microcosm of covering the climate crisis, with occasional glimpses of a brighter, greener future all too quickly overshadowed by crushing realism.

There is still hope, however, and new, transformative ideas. One that seems ripe for further exploration is personal carbon allowances (PCAs), which do exactly what they say on the tin. Everybody in the scheme gets a PCA that is automatically debited when they pay for fuel, food or consumer goods.

The allowances are tradable, so anyone who emits less than their quota can sell the surplus to somebody who has over-egged it. You can already see the incentives at work here. The magic ingredient is that the total allowance in circulation is reduced over time. If this sounds familiar, that's because it is – it is a personalised version of the emissions trading schemes that are already in operation for carbon-heavy industries in the EU, UK, China, some US states and elsewhere.

The idea of personalising carbon trading is nothing new. It was first proposed in the 1990s and has reappeared in various guises over the years, but has never made it off the drawing board. In the mid 2000s, for example, advanced economies began to sniff around PCAs as a way to incentivise lifestyle changes. France looked at transport, California at household energy and Ireland at its whole economy.

> "Everybody gets a personal carbon allowance, which is debited when they pay for fuel, food or consumer goods"

Then, in 2008, the UK carried out an influential study that essentially snuffed out the idea for a generation. The proposal was that all UK adults would be issued with a mandatory carbon account, a bit like a bank account, and a card preloaded with carbon credits that would be debited every time its owner bought fuel for transport or paid an energy bill.

This apparently simple concept quickly collapsed under scrutiny. The study found that PCAs would be unpopular, confusing, technologically challenging and more expensive than other measures. The PCA was, the study concluded, "an idea currently ahead of its time". Since then, it has been an off-limits policy.

But some ideas that were ahead of their time eventually become of their time, and PCAs are now "ripe for revisitation", according to a recent piece in the journal *Nature Sustainability*. All of the main barriers have fallen, say a team including Yael Parag at Reichman University in Tel Aviv, Israel, a member of the advisory group for the damning 2008 study.

Climate action is now in the political mainstream, and public awareness of it is much higher than it was in 2008. Technological advances have made putting it into action cheaper and easier. Smartphones are ubiquitous and AI is now advanced enough to accurately estimate individuals' carbon emissions based on GPS and purchase data.

This, of course, would require people to surrender some privacy and accept some surveillance. But the time feels ripe, at least temporarily. Parag and her colleagues point out that the pandemic has shown that people are prepared to accept restrictions on individual liberty in the name of public health that were unthinkable only two years ago. As a result, they argue, people may be more prepared to accept similar limitations on personal freedom to achieve a healthier climate.

Maybe. What is really needed is a new study, or even a field trial, to test the waters again. Ideally, the researchers say, this would be carried out in "climate-conscious technologically advanced countries". I know somewhere that fits this description. "Climate conscious and technologically advanced" could pretty much be the first line of Finland's national anthem – that is, if it actually had an official one.

One of my appointments in Helsinki is with environment minister Krista Mikkonen, so I might just make a suggestion. No, not for a national anthem, but for a trial of PCAs. Whatever the outcome of COP26, we are going to need every lever we can pull. ▮

This column appears monthly. Up next week: Annalee Newitz

IF WE LISTENED TO
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MORE RENEWABLES
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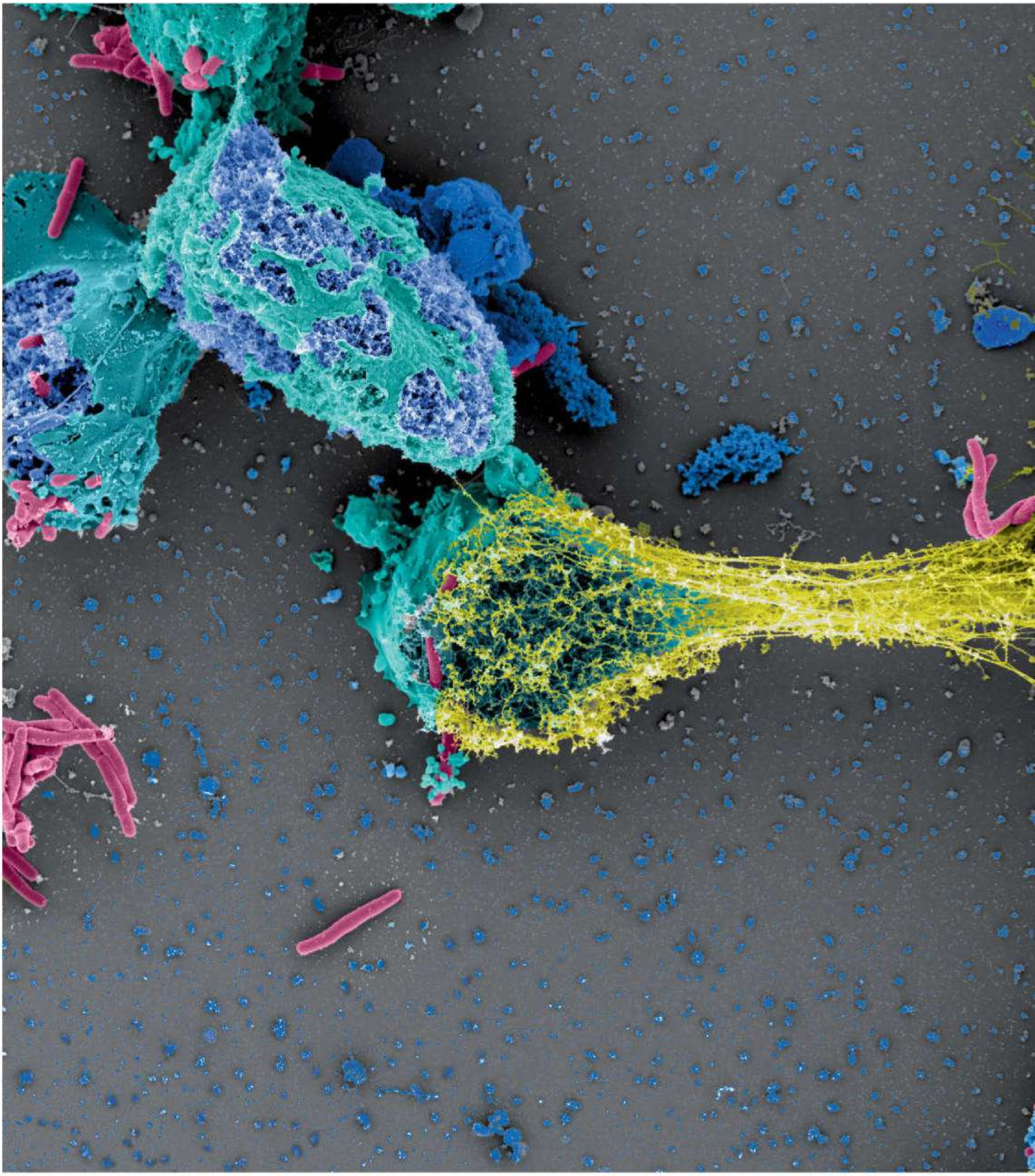

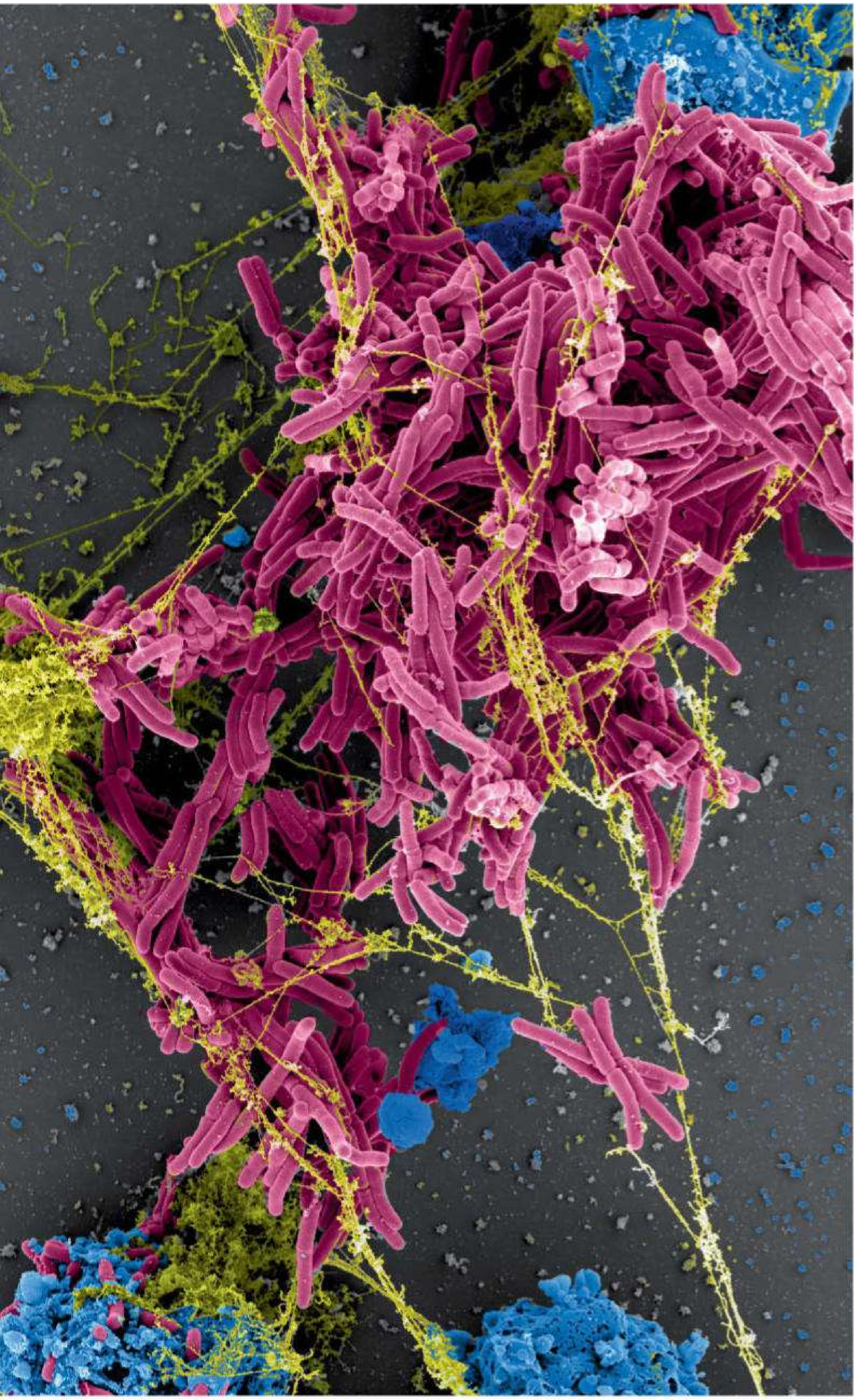

Web slingers

Photographer Chanchal Sur Chowdhury

THIS microscopic image reveals some of the intricate defences employed by our immune system against infection. Titled *Spiderman of Our Body* and taken by Chanchal Sur Chowdhury, the shot was a shortlisted entry in the Royal Society of Biology's 2021 Photography Competition.

When foreign particles or microorganisms enter the body, one of the first tactics deployed by the immune system is to try to destroy the invaders with neutrophils, a type of white blood cell. These cells, abundant in the bloodstream, travel to the site of infection and engulf the foreign agent before releasing enzymes to break it down and kill it.

Here, Chowdhury, who is at Washington University in Missouri, used scanning electron microscopy to capture neutrophils (shown in lighter blue) protecting against invading tuberculosis bacteria (pink). In a process called NETosis, the neutrophils release web-like DNA structures (yellow) known as neutrophil extracellular traps (NETs), which snare bacteria to prevent an infection spreading.

Malfunctioning NETosis has been linked to several infectious diseases, including covid-19. Too much NETosis, for example, plays a role in the development of "cytokine storms", an excessive immune system response to a pathogen that can cause serious problems such as tissue damage. ▮

Gege Li

Editor's pick

What if giant AIs really do usher in true intelligence?

9 October, p 36

From David Marjot, Weybridge, Surrey, UK

If AI is a good analogue for brains, and in particular the human brain, then it wouldn't be a surprise if increasing the power/complexity by making bigger AIs would lead to activity we would see as resembling that of the human brain, both desired and undesired.

For example, as AI structures come to "resemble" human ones, will they show features such as sensory illusions and even neuroses and psychoses? If so, would we be able to recognise these and what would be the significance of such behaviour by an AI?

From Robert Checchio, Dunellen, New Jersey, US

The question of scale as it pertains to the ability of a computer to become self-aware, a possible precondition of artificial general intelligence, has been explored at least as far back as 1966. In his book *The Moon is a Harsh Mistress*, Robert Heinlein described the human brain as having 10^{10} neurons (actually, only about an eighth of the current estimate of 86 billion), then described a computer as having one-and-a-half as many "neuristors", and how it came "alive".

Given that the GPT-3 AI discussed in your article is reported to have 175 billion artificial neurons (twice that of a human brain), Heinlein would expect human-like behaviour to appear shortly.

From John Woodgate, Rayleigh, Essex, UK

Is the result of GPT-3 so surprising? Intelligence is an emergent property, so increasing the number of network parameters is almost certainly bound to increase intelligence. A key next step, already hinted at by science fiction authors, is to give neural networks vision and hearing senses. I suspect that the results will be even more surprising, and I wonder if different AIs of this type can develop different personalities.

High gas price may be just what is required

Leader, 25 September

From Tom Leatherland, Dunfermline, Fife, UK

It is interesting to observe the media and political reaction to the natural gas price spike discussed in your recent leader article. This price may be one that some people see as more representative of its true environmental cost.

If sustained, this should be the incentive needed to get us to decarbonise at the rate we should have been doing for many years.

A few more ways to try to cut food waste

25 September, p 42

From Grace Bedell, Toronto, Ontario, Canada

How to cut food waste? Consider non-plastic storage options like airlock glass containers and reusable, beeswax-covered cloth as a plastic wrap alternative.

Waste can also be reduced with a focus on properly stored, naturally long-lasting foods such as cold-stored cruciferous and root veggies, jar-stored nuts, dried fruit, grains and beans. Cooking from dried is a good non-waste option.

Few home truths about quantum computer rise

2 October, p 20

From R. Wade Schuette, Columbia, Missouri, US

Regarding growing governmental interest in quantum computing, the rise of this technology threatens two unstoppable shifts that may change everything.

These computers will sooner or later make easy work of cracking our best encryption, laying bare decades of secrets and lies. Secondly, quantum-empowered AI will have the ability to detect when someone is lying, even from archived news footage.

The climate in which politicians and corporate executives work is about to become very transparent.

Bin tax may mean keeping rubbish under lock and key

25 September, p 18

From David Purchase, Bristol, UK

The "pay-as-you-throw" concept of a bin tax has a flaw that would need to be addressed: it requires lockable bins.

It is common for others to put rubbish in my bin, and this would get much worse if there were a bin tax. Lockable bins would be expensive, and as all the waste collection teams would need a master key, this would rapidly become ineffective.

Breezy Blighty should be fine for overnight charge

Letters, 25 September

From Derek Bolton, Sydney, Australia

Liz Bell worries that tapping electric vehicle batteries at night as a means to provide grid storage will mean they aren't fully charged in the morning. The main problem a renewables grid has is with demand in the evening. For the UK, with plentiful wind, there will be time enough to power up all the cars between, say, 11pm and 6am.

Here in Australia, we will have a higher share of solar. Everyone charging vehicles overnight will perpetuate demand for fossil fuels, while an excess of supply in daytime will undermine the profitability of solar farms. We need it to be easy to recharge EVs in the daytime, at commuter car parks and shopping centres.

Freeze your faeces for a later-life rejuvenation

2 October, p 38

From John Davnall, Manchester, UK

In "Young at gut", the possible anti-ageing value of faecal transplants was explained. There was a caveat that transplants from one person to another would meet "resistance from other resident flora".

Might this be addressed by developing storage for early age faeces, similar to that used for sperm or eggs, so that a person could receive a later transplant of their own material?

Does quantum realm explain my error ratio?

9 October, p 9

From Ben Crossley, South Wigston, Leicestershire, UK

Even though I'm resigned to never understanding quantum shenanigans, my brain went into hyper-boggle on reading that "for the first time, a quantum computer has demonstrated an error-correction strategy that fixes more errors than it creates".

However, it does explain where all the errors come from in my work: they are from a quantum dimension. Here, among collapsing functions, I will continue my good old-fashioned system of creating more errors than I fix.

For the record

In our look at the potential role of gut microbes in longevity (2 October, p 38), we should have said the many species of the Firmicutes and Bacteroidetes groups have varied dietary preferences.

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Voyages of the deep

A film exploring the passion and work of Jacques-Yves Cousteau doesn't shy away from some of his more questionable moments, says **Elle Hunt**

Film

Becoming Cousteau

Liz Garbus

National Geographic

BY HIS own account, the film-maker and ocean explorer Jacques-Yves Cousteau hated it when his work was labelled as "documentary". "That means a lecture by a guy who knows more than you," he wrote. "Our films are true adventure films."

Becoming Cousteau, a new documentary about Cousteau's life and legacy, captures that spirit without getting too swept away. The result is a captivating portrait of a complicated man who was as well-known and widely beloved as David Attenborough is today.

Veteran film-maker Liz Garbus was first approached by National Geographic to make a film about Cousteau's life in 2015. It was only in 2019, after years of negotiation, that Garbus was granted exclusive access to the Cousteau Society Archives, controlled by Cousteau's widow Francine. Their children, Pierre-Yves and Diane, have co-producer credits on the film, but in Garbus's hands, the involvement of those closest to Cousteau serves as an asset, not a liability, helping to paint a picture of a true original.

Cousteau was a born explorer, with an insatiable drive to see the world and a talent for sharing what he found. He started making films aged 13 and, at 20, entered the French naval academy with a view to becoming a pilot. When his career in aviation was cut short by a car accident, he began swimming on the French Riviera to help heal his broken bones, before becoming fascinated with freediving.

Soon, he became frustrated with the limits of freediving and, with his naval colleagues, experimented with breathing apparatus that would allow them to spend more time underwater. This led to the invention of the aqualung, which made diving more accessible for both scientists and amateur explorers.

Archival footage captures the fear and thrill of those early dives, which weren't so far removed from space exploration at the time in terms of the risks involved.

In 1947, diver Maurice Fargues died while attempting to set a new depth record with the aqualung. This only focused Cousteau's mind further. Fargues's death must not be in vain, Cousteau said.

His ultimate goal, at that time, was utopian, "paving the way to a time when human beings will live continuously under the sea". For Cousteau, diving proposed a route to liberation not just for him, but for all humankind, "to eliminate all ties to the surface".

The spirit of this mission was embodied by his research vessel the Calypso, spoken of by its crew as something between a safe haven and a spiritual calling. "This escape would not exist if people were happy on land," says one sailor. Footage of life onboard from the mid-1950s through the 60s gave ocean exploration a certain glamour. It is no wonder Cousteau's work inspired a generation of film-makers and seafarers.

"Cousteau abandoned his dream of undersea civilisations to fight for oceans that could support life at all"

While celebrating Cousteau's many triumphs, Garbus also engages with his life and work through a contemporary lens, interrogating the cowboyish tactics – such as blast-fishing with dynamite and slaughtering sharks as sailors' revenge – that were in line with the pioneering spirit of the time, but are antithetical to conservation interests today.

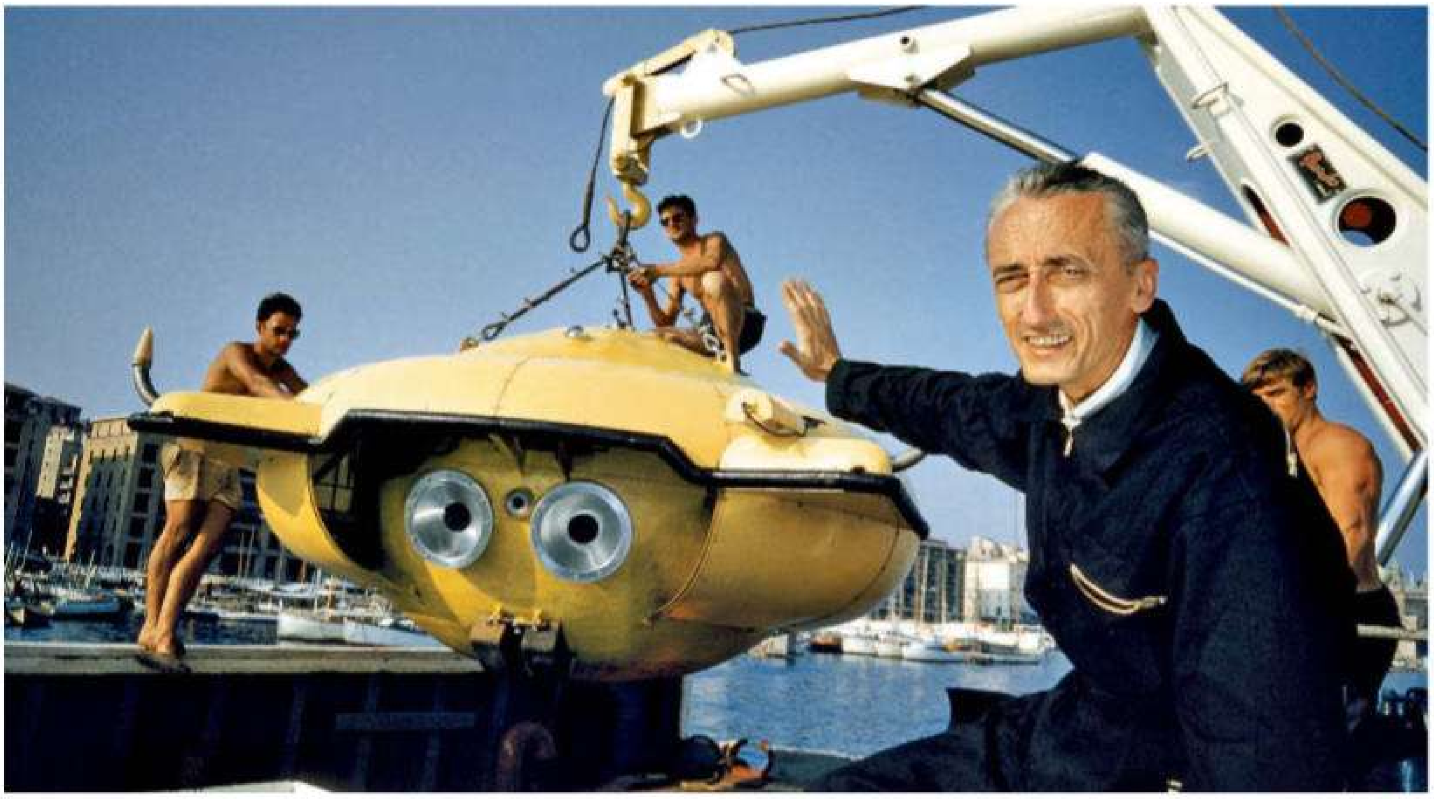
In 1953, the Calypso – only ever one cheque short of financial ruin – even accepted funding to search for oil in the Persian Gulf. "We just didn't know any better at the time," says a crew member.

Cousteau himself was quick to change course. By the 1970s he had stopped showing his early films, saying "the mentality has changed", and threw himself into lobbying for protection of the marine ecosystem.

After documenting two decades of decline, he abandoned his dream of an under-the-sea civilisation to fight to ensure that oceans could support life at all. His series – "no more about dealing with beautiful little fishes, [but] the fate of mankind" – was dropped from US television for being doomsaying.

Cousteau's warnings for future generations are even harder to hear now, after 50-plus years of inaction. But his story inspires hope about what can be achieved by one person with a vision. ▮

Elle Hunt is a freelance journalist based in Norwich, UK



Jacques-Yves Cousteau was a pioneer of underwater research

THOMAS J. ABERCROMBIE/NATIONAL GEOGRAPHIC

Real friends don't glitch

A cute yet flawed robot is a timely reminder of the importance of real-life connections, says **Hanna Flint**

Film

Ron's Gone Wrong

Disney

In UK cinemas now

DISNEY

In *Ron's Gone Wrong*, a lonely boy befriends a malfunctioning robot that fell off the back of a truck

***Ron's Gone Wrong* isn't the first Disney film to employ a white, rounded robot with circular black eyes to befriend a lonely kid. *Big Hero 6* presented a similar human-android team-up to great acclaim in 2014. But while that film was designed with the themes of grief, hatred, forgiveness and, ultimately, the effectiveness of non-violence in mind, *Ron's Gone Wrong* is more concerned with the dilemma of social connections, both online and off.**

The film tells the story of Barney (Jack Dylan Grazer), an introverted pre-teen from a low-income household who is raised by single dad Graham (Ed Helms) and live-in grandmother Donka (Olivia Colman). Barney is the only child at his middle school who doesn't own a B-bot, a brand new robotic device installed with an "algorithm for friendship" that was created by young, hoodie-wearing tech CEO Marc (Justice Smith).

Designed to be a "best friend out of the box" for children around the world, each B-bot is tailored to its user via data harvested from their online behaviour and social media profiles. However, when Barney is given a malfunctioning B-bot for his birthday, one that literally fell off a back of the truck, it takes on a mind of its own and becomes Ron (Zach Galifianakis).

Given the history of robots with free will in sci-fi, the plot could have easily gone down the technological uprising route seen in the *Terminator* franchise or *The Mitchells vs the Machines*, but there is something rather refreshing about the characterisation of an AI that develops its own identity by pursuing love and friendship. It brings to mind a short story from Malka Older's *...And Other Disasters* collection about an AI that has developed human emotions because of the scientist, or "mother", that raised it.

Similarly, Ron's increasingly caring, playful and protective bond with Barney is heart-warming to watch, especially when their journey takes them into the great outdoors for a few misadventures. It certainly wouldn't be a Disney animation without some slapstick set pieces, cultural caricatures or random animal sidekicks to help push the plot forward, and some of these bumps in the road are amusing to watch. A scene in the school playground where Ron's unlocked coding spreads like a virus to other bots is an amusingly chaotic, yet ominous, sight to behold.

This is where the film's sinister undercurrent begins to spark, swiftly turning into a cautionary tale about letting children spend too much time on their devices to the point where they become hooked on making an impression online. There are some not-so-subtle messages about evil aspects of profit-driven big tech companies, surveillance society, data harvesting and the dangers of sharing too much of yourself on the internet. In fact, there is a surprising amount of thematic crossover with Netflix's *The Social Dilemma* for a children's film.

And yet, despite the rich voice performances, the characters – and the supporting ones in particular – seem frustratingly underdeveloped. The plot structure and narrative beats are overly formulaic, too. The story sets up the issues of economic disparity, technological inequality and the social effect of technology on children, but never truly broaches the subject.

Instead, the script favours the more simplistic concept of "make friends offline, not online", though the ending doesn't efficiently complete that train of thought. Still, *Ron's Gone Wrong* isn't without a heart or a social conscience, and a viewing might just inspire you to switch off your devices and catch up with friends in real life instead. ▮

Hanna Flint is a film critic and writer based in London

Don't miss

Read

Fabric is a retelling of global history through the medium of cloth. Victoria Finlay explores the origins, culture and science of the world's fabrics, from sacking to silk, and uncovers what they mean to our lives today.

Watch

Invasion, created by Simon Kinberg and David Weil, employs Sam Neill's thousand-yard stare and gravelly voice to epic effect. Apple TV+'s chronicle of an alien invasion, witnessed from multiple perspectives around the world, is out now.

Play

Marvel's Guardians of the Galaxy are back to save the world, but only if you press the right buttons. The antics of Peter Quill and his friends are set to an 80s soundtrack, from Wham! to Iron Maiden, KISS to Blondie.

INVASION: MACALL POLAY/APPLE; GUARDIANS OF THE GALAXY: SQUARE ENIX

The games column

Stuck in a quantum loop

Deathloop is an ambitious time-bending shoot-'em-up with puzzles and action aplenty, but it is ultimately let down by some frustratingly loose ends, says **Jacob Aron**

Jacob Aron is *New Scientist*'s deputy news editor. Follow him on Twitter @jjaron

Game
Deathloop
Arkane Studios
PC, PlayStation 5

Jacob also recommends...

Games
Dishonored
Arkane Studios
PC, PlayStation 3 and 4, Xbox 360 and One
Play as an assassin in a whale oil-fuelled alternative version of Victorian-style England, in a game sharing a lot of DNA with Deathloop.

Bioshock
Irrational Games
PC, PlayStation 3 and 4, Xbox 360 and One
Arkane's aesthetic is heavily influenced by Bioshock, *set in a city under the sea where Ayn Rand's libertarian philosophy has gone horribly wrong.*

BETHESDA

Getting out won't be easy when everyone else wants to stay in the loop

IN MY review of *The Forgotten City* a few months ago, I said that time loop stories are rare in video games. If I could go back in time, I would recant that. This year has seen a veritable glut of *Groundhog Day*-'em-up games, including *Twelve Minutes*, a thriller starring James McAvoy, Daisy Ridley and Willem Dafoe, and *Deathloop*, which is probably the most ambitious of the lot.

Deathloop sees you play as Colt Vahn, who wakes up on the beach of the mysterious island of Blackreef having seemingly been killed by an unfamiliar woman. You quickly discover that the island has been put into a time loop by an organisation called the AEON Program. The same day, the first day of the loop, is endlessly repeating, and if you die before it ends, you return to the beach.

Only two people remember the events of the previous loop – Colt, who has only just started to remember, and Julianna, the woman who killed him and seems to have been aware of the loop for some time. Colt is determined to break the loop and escape, while Julianna has pledged to stop him.

He can only succeed by killing Julianna and seven other members of AEON known as Visionaries, who are keeping the loop active using artefacts called slabs that provide them with abilities, such as invisibility or teleportation, which you can claim for yourself. Exactly how it all works is pretty hand-wavy, though a dose of quantum physics seems to be involved, as is often the case with these things.

> "Blackreef is inhabited by Eternalists, who have joined the island to enjoy a life of partying and killing"

Blackreef is a strange place, draped in 1960s kitsch and littered with retro-futuristic tech. Along with the Visionaries, it is inhabited by Eternalists, people who have joined the island to enjoy a life of unbridled partying and killing.

You explore the island by visiting one of four locations in either the morning, at noon, during the afternoon or in the evening – after that, the day loops again. These locations change throughout the day, so that a route that is accessible in the morning might be blocked in the evening, or certain events might only happen at noon. Since you can visit just four of the possible 16 combinations of location and time before the loop restarts, it initially isn't possible to kill the seven Visionaries in one go. You need to figure out ways to get them to the same place and time.

Essentially, it is one big puzzle, with Colt picking up information, weapons or a slab and using them on the next loop. Colt and Julianna trade barbs via radio at the start of each loop, and their evolving relationship is key to the game – as Julianna is the only other person who remembers the previous loops, she can appear at any point in the game to interfere with your plans. There is even a multiplayer mode that allows you to play as Julianna and drop into someone else's game, which is a fun twist.

The out-of-time island of Blackreef, with its various secret bunkers, strongly evokes the TV series *Lost*, and, just as with the show, I found myself drawn deeply in as I tried to piece together what was going on. Unfortunately, like *Lost*, I was gradually worn down by the pieces of story that never quite gel together or fully explain themselves, and found the ending ultimately unsatisfying.

Deathloop is one of the most interesting games released this year, but it isn't quite as good as it could have been. Maybe a sequel will give its developer, Arkane Studios, a chance to get it right next time around. ▮

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Good COP, bad COP

What will a favourable outcome of the COP26 climate conference look like, asks **Adam Vaughan**

IT ISN'T often that international summits are pitched as a "turning point for humanity". But that is how UK prime minister Boris Johnson described the COP26 climate conference in Glasgow, which starts on 1 November, in a speech to the UN this September. The question is which way we will turn. To within touching distance of a safe future climate comparable with the past 10,000 years or so that enabled humanity to flourish? Or continuing towards a hothouse Earth with higher sea levels, extreme weather getting worse, more wildlife wiped out – and an incalculable burden on the well-being of future human generations?

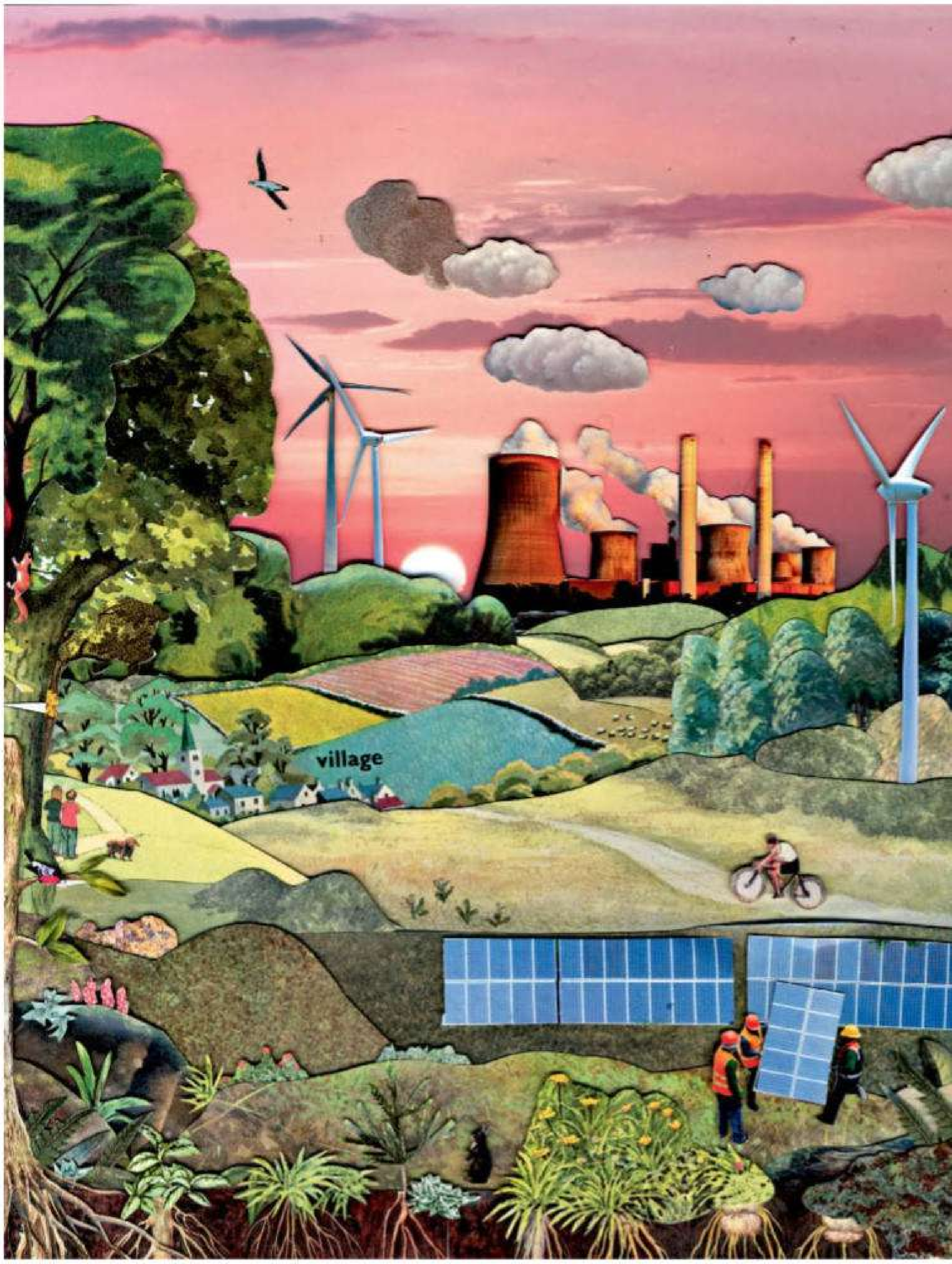
The person charged with making the summit a success, COP26 president Alok Sharma, is adamant that the fortnight-long meeting, delayed for a year because of the covid-19 pandemic, can maintain hopes of limiting global temperature rise to 1.5°C, the goal agreed at the 2015 Paris climate change summit. "I think keeping 1.5°C alive has to absolutely be the aim," he says.

"We don't have another option. If this summit doesn't keep 1.5 degrees alive, we are in such trouble," says Christiana Figueres, former chief of the United Nations Framework Convention on Climate Change (UNFCCC) and one of the architects of the Paris Agreement. "We have only the last years of this decade to make a major, major turnaround."

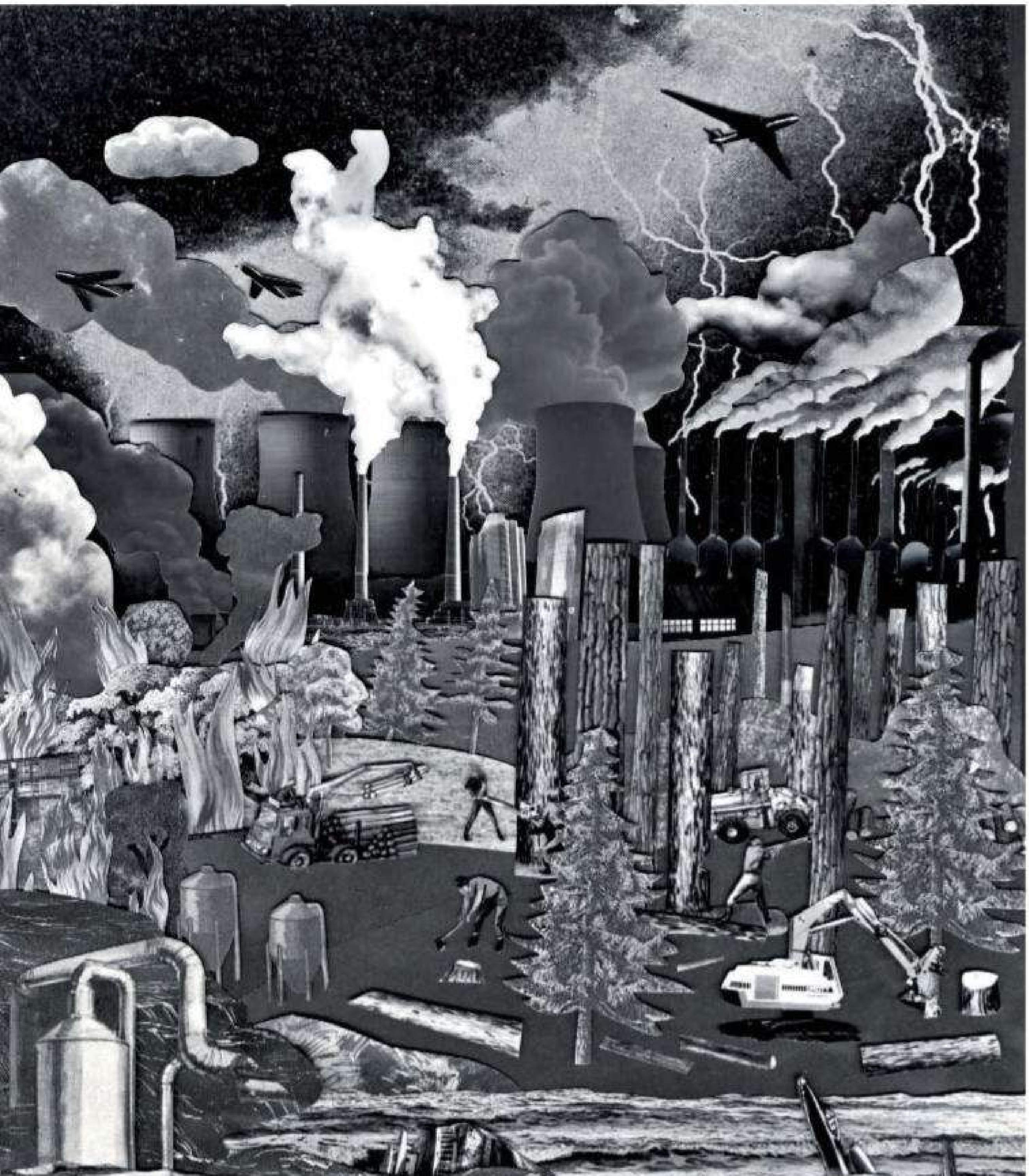
After years of tough talks, those involved will be keen to trumpet their success following the summit, whatever the result may be. But what will an outcome that is genuinely good for us and the planet look like? Read on for your guide to the key issues that will determine all our futures.

The emissions gap

The absolute biggie facing the UN and the UK, which as host of the summit has been spearheading the diplomatic effort leading up to it, is the 20 to 23 billion tonnes of extra carbon dioxide cuts needed each year to avert



BEN GILES



truly dangerous warming. That is what one analysis estimates as the extra annual emission reductions needed by 2030, on top of those that countries have already pledged, if we are to avoid breaching 1.5°C. Global emissions are currently about 40 billion tonnes of CO_2.

Nearly 200 countries agreed in Paris in 2015 to "ratchet up" their plans to reduce emissions, known as nationally determined contributions (NDCs), with an initial deadline of December 2020. Very few met that schedule. The UK, European Union and US all submitted bolder new pledges for cuts by 2030. But some, such as Australia and Indonesia, issued new ones with the same old targets. Others, including Brazil and Mexico, even effectively watered down their targets. Brazil said emissions in its base year of 2005 were a third higher than stated in its older plan, meaning it can emit more now and still meet its goal. The largest emitter, China, and fourth biggest, India, have yet to submit their revised plans.

The result, according to a report published by the UNFCCC in September, is that global emissions are set to rise by 16 per cent by 2030, on 2010 levels, instead of falling by 45 per cent, which is what's needed for a chance of staying under 1.5°C. A 16 per cent rise puts us on course for a world 2.7°C hotter by 2100, catastrophic warming that would turbocharge extreme weather, hit food production and destroy unique ecosystems such as coral reefs. Sharma concedes that the figures are "pretty sobering".

Top of his agenda is putting pressure on G20 countries, leading economies which account for about four-fifths of global emissions, to fulfil a promise they made in July to deliver ambitious new plans in time for the summit. "What the G20 do is absolutely vital," says Sharma. "The key issue now is how do we get these G20 nations to come forward." India, Russia, Saudi Arabia, South Africa and Turkey are among G20 members with no new plan, yet.

Patricia Espinosa, the current head of the UNFCCC, argues that the UN report shows 1.5°C is still possible, because some political › promises – such as Chinese president Xi Jinping saying his country's emissions will peak before 2030 – have yet to be translated to a formal plan. "The 1.5°C goal is, in my view, alive. One thing we cannot do is give up," she says.

Some observers say it is unrealistic to expect COP26 to single-handedly close the "emissions gap" enough to put us precisely on track for a 1.5°C world. But the summit can still do enough to keep that option open. "We can't do all we need to do in Glasgow to get on track for 1.5°C, but we need to keep 1.5°C alive. We should not despair," says Peter Betts at the Chatham House think tank in London. Betts is a former lead climate negotiator for the UK and EU.

Farhana Yamin, an adviser to the Climate Vulnerable Forum, a group of 48 countries particularly threatened by global warming, is less positive. "A good COP is just a misnomer. We are heading towards plus 16 per cent in terms of emissions when we should be on minus 50 per cent. That's the reality," she says.

Still, several veterans of climate talks think that most countries will have submitted new plans by the time 100-plus world leaders line up to give their opening speeches in Glasgow on 1 and 2 November. Some heads of state may even wait until those speeches to announce their plans. No country will want to be singled out as the villain of COP26 by failing to submit one. However, there is little expectation that laggards such as Australia and Brazil will beef up their retrograde contributions, despite Espinosa reminding governments they can revise plans at any time. One reason for hope is that countries may agree to speeding up the current five-year cycle for submitting new emissions reduction plans. The next batch isn't officially due until 2025.

Good COP:
China and India announce NDCs that are more ambitious than their previous ones, even if they fall short of a "fair share" towards the 1.5°C goal; virtually all countries submit a plan by around the opening of the summit.

Bad COP:
China or India put forward a rehash of old plans without any extra emissions cuts; any G20 countries failing to submit a plan.

Wildfire threatens homes in Chino Hills, California, during October 2020

> **"No country will want to be singled out as the villain of COP26"**

Fossil fuel squeeze

Phasing out fossil fuels isn't explicitly on COP26's agenda. It isn't even mentioned in the Paris Agreement. But if you take that accord's 1.5°C goal seriously, it implies that 89 per cent of known coal reserves, plus 58 per cent of oil and 59 per cent of gas, must stay in the ground.

Diplomatic efforts are focusing on four ways to put the squeeze on fossil fuel companies. First is securing coal phase-outs in the OECD group of 38 mostly high-income countries. Germany is one outlier here, proposing an end date as late as 2038, an issue in its recent national election. A measure of success of the summit will be how many countries commit to phasing out coal. In June, five more joined an existing list of 35 nations. One thing that is unlikely to happen at the summit, but crucial to reining in warming, is big coal users such as China and Indonesia announcing a timeline

DAVID MCNEW/GETTY IMAGES

for retiring ageing and polluting coal plants.

Second is cutting finance for new coal power stations worldwide. Pressure ahead of COP26 has already secured a big win, as China said on 22 September it would end coal financing beyond its borders. Bernice Lee at Chatham House says although the move was anticipated, it isn't painless. "Credit where it is due. China was the largest public financier of coal projects overseas, so this really closes an important loop after South Korea and Japan made the move [ending coal finance]," she says.

A third priority is cutting finance from public banks, export credit agencies and multilateral development banks to oil and gas. Denmark and Costa Rica have blocked future oil and gas production and are crafting an alliance of other countries to do the same. The fourth lever is an effort to get more countries to follow the UK's lead among major economies in setting an early date for banning sales of new petrol and diesel cars.

Depending on what is announced, and how many large companies also declare emissions reduction plans while the summit is on, the effect could be cuts equivalent to billions of tonnes of CO_2, putting such "real economy" action on a par with countries' national plans. "There are really good news stories in almost every sector of the economy," says Rachel Kyte at Tufts University in Massachusetts. She says that should be celebrated, but firms and governments at COP26 also need to demonstrate that technologies to decarbonise tricky sectors, such as methods to produce steel without using coking coal and powering ships with alternative fuels such as methanol, can really get beyond pilot projects.

Good COP:
Significant growth in the number of countries, regions and cities planning to phase out fossil fuels. Corporate pledges that amount to emissions reduction of billions of tonnes.

Bad COP:
Financiers and countries such as China simply reiterate pledges made before the summit.

Climate finance

In 2009, high-income countries promised that by 2020 they would give $100 billion a year in climate finance to lower-income nations, to help them adapt to a warming world and cut their emissions. The pledge was pivotal for unlocking the goodwill and multilateralism that delivered the Paris Agreement. Yet there was still a $20 billion shortfall in 2019, a gap that was almost unchanged from the year before. Data for 2020 isn't yet in, but it is clear that meeting the promise by the time COP26 starts is essential to oil the wheels of the final negotiations. "If the contours of the financial package are not clearer by the time we arrive in Glasgow, that becomes the open wound," says Kyte.

If the $100 billion doesn't appear, that "simply makes the credibility of the developed countries and the COP26 presidency disappear into thin air", says Saleemul Huq at the International Centre for Climate Change and Development in Dhaka, Bangladesh. It isn't so much the difference the money will make, which Huq calls "trivial" given the impacts countries are facing. It is a matter of trust in rich countries' promises, given that it represents a pledge made over a decade ago. "If they still cannot deliver it, a year late in Glasgow, then simply they have no credibility to talk to anyone, about anything," says Huq.

Sharma is acutely aware of the issue's importance. "This $100 billion figure has become absolutely a matter of trust in politics, but particularly in climate politics. Trust is pretty fragile. We need to rebuild this trust if we're going to get everyone on the same page," he says. The race is now on to close the $20 billion gap. Denmark and the US helped in September by promising new funds, but a final accounting awaits to see if the $100 billion materialises.

Even if met, that finance pledge only covers the years to 2025. Delegates in Glasgow will need to discuss climate finance beyond that. Those talks will not yet be about the amount of money, but what sort of considerations should be taken into account to arrive at a figure.

There is also a separate ongoing branch of the talks, the Warsaw International Mechanism, which is exploring how to address the financial hit faced by countries dealing with climate change's impacts. "We are now in the era of loss and damage," says Huq, referring to recent floods, famines and wildfires. It still remains to be worked out how vulnerable countries could get more help or money to cope with everything from extreme weather to longer-term threats such as sea level rise. Huq says COP26 should make the Warsaw International Mechanism an annual high-level agenda item at climate talks.

Good COP:
The $100 billion figure materialises by the time the conference doors open and constructive talks take place to discuss how a future finance commitment might be agreed.

Bad COP:
Fudges and promises of the money being delivered later down the line.

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Adaptation in the spotlight

Adapting to climate change is the focus of day one of the second week of COP26, and will be discussed throughout by a body known as the Adaptation Committee. Adaptation to climate change, for example with better flood defences, has always played second fiddle to mitigation at these conferences, but this meeting is expected to see important discussions on a potential new goal around adaptation.

"We need to agree what we need on adaptation, on how to measure it," says Kyte. What that looks like is complicated, says Huq. That is because mitigation to keep climate change in check can be aggregated under a global goal, such as avoiding warming above 1.5°C, but adaptation will be specific to location. One country may require flood defences, a second might need to switch to growing a new crop, another may have to slow desertification. That is why some observers think the only metric that countries will be able to agree on is the amount of money given for adaptation.

Nonetheless, other ideas are being floated. South Africa has suggested trying to measure the ability of communities to cope with extreme weather, and proposed a goal that increases that resilience by 50 per cent by 2030.

Good COP:

Agreement on a new goal for adaptation and how it will be measured.

Bad COP:

A new goal that kicks the issue of metrics down the road.

The Paris Rulebook

When COP21 president Laurent Fabius brought down the gavel agreeing a deal in Paris six years ago, it was the first time that high and low-income countries had together agreed to act on their emissions. But negotiators hadn't reached a consensus on several arcane but important bits of small print. Chief among the outstanding issues surrounding the "Paris Rulebook" is Article 6, which deals with rules for a global market trading credits for carbon reductions.

Essentially, this would allow countries that overshoot their emissions reduction targets to sell that "surplus" to other countries that might be lagging or have less capacity to cut emissions. If done right, this could be a win-win: the atmosphere doesn't care where emissions are cut, and countries and firms are given incentives to cut emissions more.

> **"Carbon trading could be a win-win if done right – but the devil is in the detail"**

But the devil has been in the detail of the system's governance. One past flashpoint is the rule on double-counting of credits – where two parties claim credit for the same emissions reduction, such as Brazil counting avoided deforestation and Norway buying credits for that. Another point of dispute is whether credits from a previous international climate treaty, the Kyoto Protocol, could be carried over.

Agreement has proved intractable at successive summits since Paris. Sharma has warned countries are still a "way off" consensus and a breakthrough will be a "challenging task". Still, Figueres believes the impasse can be broken. "It's not simple, but it's also not rocket science," she says.

As she notes, there was a carbon market

A message to climate leaders at New Brighton beach in Wirral, UK

Countdown to COP26
Sign up to Adam Vaughan's newsletter for the latest on the climate conference at **newscientist.com/sign-up/**

under the Kyoto Protocol, known as the Clean Development Mechanism. It was flawed: at times the price for cutting a tonne of CO_2 reached such lows it made projects unviable. Concerns were raised over how many of the projects, such as new wind farms, were "additional" to what would have happened regardless. However, Figueres says an upgraded Clean Development Mechanism could and should be inserted into the Paris Agreement in Glasgow. "Let no one say we don't know how to do it, because we do," she says.

Good COP:
A breakthrough on Article 6, with agreement on common time frames for national emissions reduction plans and data reporting standards.

Bad COP:
Agreement on Article 6, but with so many compromises that few companies and countries have faith in its environmental integrity.

> **"The mood of different countries can affect what is possible in the COP"**

CHRISTOPHER FURLONG/GETTY IMAGES

Putting it all together

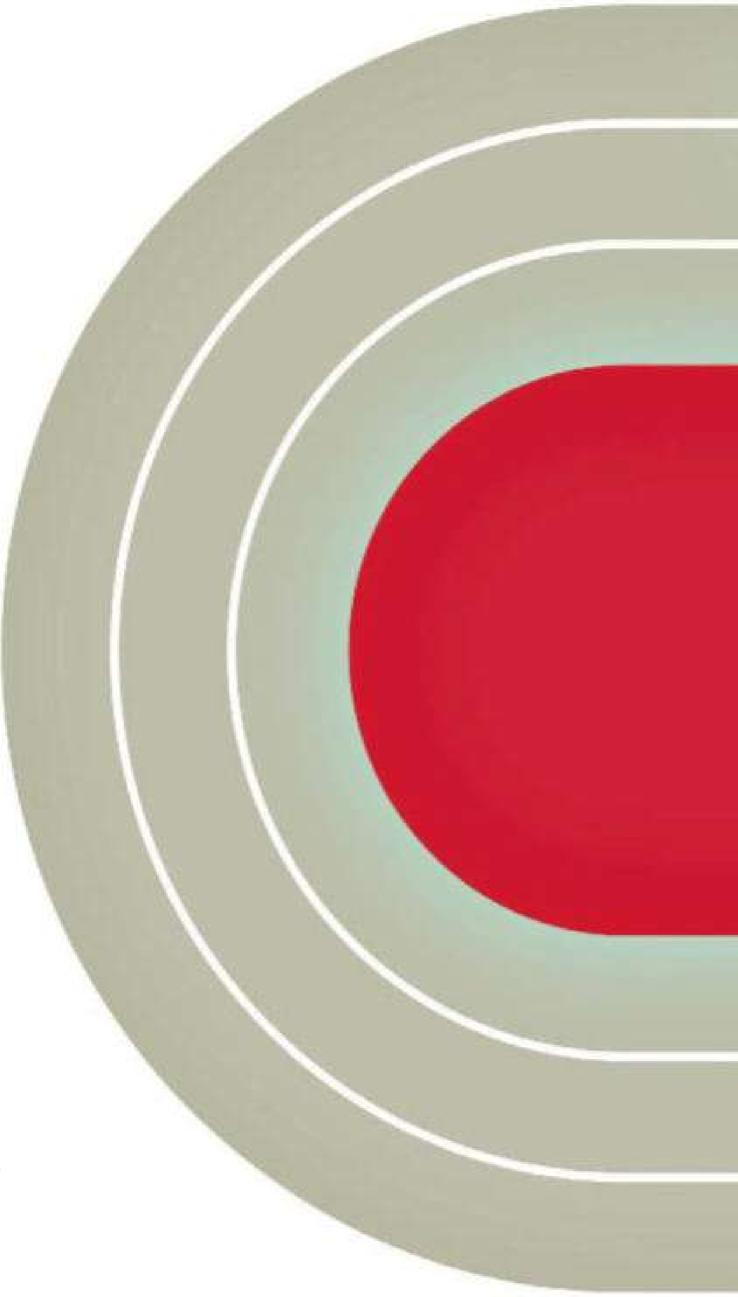
"A key problem of this COP is defining success when you're not going to get everything you need," says Betts. One long-time climate talks observer, Nick Mabey at the European think tank E3G, says that if enough ambitious national emissions plans materialise and progress is made on squeezing fossil fuels through phase-outs and cutting financing for them, Glasgow will be a success. Mabey says a "stretch target" for COP26 would see countries also committing to align their short-term climate goals with their long-term ones, ensuring that the serious business of cutting emissions starts now. Another marker of an ambitious outcome would be an explicit commitment to 1.5°C being the global goal, dropping the Paris Agreement's ambiguity of also tilting at a backstop of "well below 2°C".

One sign of a good COP will be if the UK's presidency of the summit is impartial and the conference runs smoothly, keeping enough delegates happy. Sharma is aware of this, describing himself as a "neutral broker".

Copenhagen in 2009 was a lesson in how not to run such a conference. Basic operational mishaps, such as leaving some delegates queuing for hours in the snow, led to anger. "COPs have their own dynamics. You've got tens of thousands of people all milling about for two weeks without sleep," says Betts. "There is a lot of dissatisfaction in the developing world about covid, vaccine access and climate impacts. Mood can affect what's possible in the COP."

Sharma hopes the relationships he has built by visiting at least 30 countries in the past year will help him avoid the mood turning sour. He says his aim is to iron out the really thorny issues of the Paris Agreement before the conference hall even opens in Glasgow. Above all, he sees little alternative to a successful COP26. "We have to get this right, for our generation and future generations," says Sharma. A bad outcome won't stop the efforts to fight climate change. But for most observers, this is our last chance to make a convincing turn to avoid the worst. ▮

Adam Vaughan is chief reporter for *New Scientist* and author of our Fix the Planet and Countdown to COP26 newsletters



Speed trials

The way we test medicines is rigorous but slow. **Carrie Arnold** investigates the controversial new kinds of clinical trial that promise faster results

HUNDREDS of years ago, if you had a pain, a cough or a fever, an apothecary might prescribe you a tincture or – joy – a restorative course of leeches. Thankfully, medicine has come a long way since then. It is by no means perfect, but hospitals, drugs and healthcare have made our days inestimably more comfortable.

Much of this is thanks to that bastion of science, the clinical trial, which tests whether a medicine or treatment is safe and effective. Evidence from such trials is considered the gold standard, and over the years it has helped us sort the quackery from the cures. It might be surprising to hear, then, that a growing number of doctors think the way we test medicines needs an overhaul.

For all their strengths, clinical trials often take years to deliver a verdict. This drawback was exposed during the covid-19 pandemic, when we desperately needed treatments for a new disease. Doctors were forced to use quicker methods of assessment, and at this juncture, it seems they paid off. "We were able to achieve in weeks what would have otherwise taken years," says epidemiologist Martin Landray at the University of Oxford.

If we can get robust answers about medicines in a faster way than standard clinical trials can, surely we are ethically obliged to do so. Some say yes: helping more people more quickly must be a good thing. Others worry that rushing medicines into use has got us into trouble before. Whether there really are speedier, more reliable ways of doing clinical trials is rapidly becoming one of the most critical questions in medicine.

The origins of the clinical trial can be traced back to a major problem faced by British sailors in the middle of the 18th century. Thousands of them were dying of scurvy, a condition that causes spontaneous bleeding, pain in the limbs and ultimately death. A physician called James Lind suspected that scurvy could be cured by changes to sailors' diets and, in 1747, he set up a small but pioneering test of the hypothesis. He divided 12 men with scurvy into six groups and augmented their diets in different ways. The ones who got extra fresh fruit fared much better than the others – and the rest is history.

Lind got the right result. But his test was missing two elements – apart from scale – that we now consider crucial to a clinical trial. First, is the control group. In modern clinical trials, people receiving a new drug or treatment usually aren't compared against those getting other, similar treatments, but against a group

MARTIN LEON BARRETO

receiving a placebo, a dummy pill. The point is to have the control group treated in what seems like the same way, so that the difference between this group and those given a new treatment can be understood clearly.

The second important facet is randomisation. When you divide people up, you can accidentally introduce differences between the groups without realising it. We know, for instance, that doctors sometimes subconsciously choose healthier individuals to receive a new drug, which can make it look as if an ineffective treatment works.

These two key ideas were first put into practice in a 1947 trial involving the newly discovered antibiotic streptomycin. The US doctors who ran the trial used a system that ensured neither the doctors nor the patients knew who was receiving the drug and who was getting the placebo until the end. This format coalesced into what we now call a randomised controlled trial, or RCT. Today, trials proceed through phases I, II and III, which test drugs' safety and efficacy on progressively larger groups of people.

The system works. But even before the pandemic hit, it was clear that it came at a high price. Between 2015 and 2016, the median cost of a clinical trial was $19 million, much of which was paid for by pharmaceutical companies, which claim this contributes to high drug prices. Then there is the time it takes to chaperone a drug from invention through trials to approval, which is often upwards of 10 years. Trials can also be costly to the volunteers themselves. There is often a 50:50 chance that someone involved in a trial will get only a placebo. Perhaps that explains why participation is woefully low – a 2017 study found that only 4 per cent of people diagnosed with cancer choose to take part in an RCT.

Doctors have been bothered by all this for a long time. In the early 1980s, Robert Bartlett, a surgeon at the University of Michigan, wanted to test whether extra-corporeal membrane oxygenation (ECMO) machines could be used to do the work of the heart and lungs in premature babies. Until then, the

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"It often takes upwards of 10 years to chaperone a drug from invention to approval"

machine had only been used in adults. Bartlett used an unorthodox trial design that borrowed from game theory. The first infant enrolled would receive the standard kind of ventilation at the time, which involved a continuous positive airway pressure, or CPAP, machine. If it survived, the next would receive the same standard care. If it died, the second enrollee would be hooked up to an ECMO. The first baby died. The second received ECMO and survived. So did the third, the fourth, and all the rest up until the 12th baby. Given that nearly all similar premature babies had died without ECMO, Bartlett felt it was case closed.

Bartlett's peers thought the trial was too small, however, and the design too unorthodox, to accept ECMO as the new standard of care. According to clinical statistician David Robertson at the University of Cambridge, the reception of Bartlett's work put others off trying out new kinds of clinical trial for years to come. ECMO wasn't accepted until 1996, when a group of UK scientists assessed the machine using a full-blown RCT that involved 185 babies. As in Bartlett's trial, ECMO easily proved superior to regular treatment. For Edward Mills at McMaster University in Hamilton, Canada, though, it was a pyrrhic victory. As a father, he says, all he can think about are the babies who didn't make it. "Did all those kids really have to die just to prove a point?"

In the 1990s, more doctors started to gradually experiment with adaptations of the clinical trial. This produced two basic kinds of novel trial that each address different shortcomings of traditional RCTs (see "Trials on trial", below).

> **"The way we carry out clinical trials is like building a new stadium for every football game"**

Trials on trial

Two newer methods for assessing drugs or treatments are growing in influence. How do they stack up against randomised controlled trials, the gold standard for generating medical evidence?

	What is being tested?	How are participants randomised?	When does it end?	Pros?	Cons?
RANDOMISED CONTROLLED TRIAL (RCT)	Whether one specific drug or treatment is effective at treating a specific condition	They are randomly assigned to two groups, with one getting the test treatment, the other a placebo or standard care	At a set point in time, determined before the trial starts	Provides highly reliable results that are easy to replicate	Often takes years, requires a large control group and can only test one drug at a time
ADAPTIVE TRIAL	Whether one specific drug is effective, much like an RCT	Statistical algorithms determine the chances that a participant will receive a specific treatment or placebo	If certain pre-planned conditions arise, the duration of the trial can change. For instance, it can be cut short if the drug doesn't work	Fewer patients are given a placebo and the trial can take into account effects that doctors didn't initially expect to find	The design is complex, making it harder for other doctors to repeat and confirm the findings, and it needs high-level statistical expertise
PLATFORM TRIAL	Which of several drugs or treatments is the best at treating a condition	Patients are randomly assigned to several "arms", one of which gets a placebo, the others, different drugs. New arms testing new drugs can be added after the trial has started	Different arms can be ended before others if certain drugs show no sign of efficacy. Tests of the most successful drug end when researchers have enough evidence	Tests multiple drugs at the same time, giving quicker results overall	Requires a larger investment of planning time upfront

RGB VENTURES/ALAMY

The first modern clinical trial involved testing the antibiotic streptomycin

The first big problem with conventional trials is that they build the same research infrastructure for each and every drug tested. Everything from the recruitment of administrative staff to bed space and the statistical models are organised from scratch for each trial. That is like building a new stadium for every football game, says statistician Munya Dimairo at the Sheffield Clinical Trials Research Unit, UK.

To get around this, clinicians now sometimes use what is called a platform trial. Here, scientists create an infrastructure that can be used again and again. What's more, researchers can share a single control group across multiple trials of different drugs, as well as test therapies head-to-head against each other. This kind of trial doesn't ask "is one particular drug effective?", but "which drug is the best at treating a certain condition?".

A second shortcoming of RCTs is that lots of participants are given a placebo. An approach that takes the edge off this is called an adaptive trial. You might think of these like a modern variation of Bartlett's research. In these trials, patients aren't randomised into groups, with each receiving different treatments. Instead, the treatment each person gets is determined by rules that are written before the trial. For example, if lots of patients have benefited from a particular drug, then the odds that a patient coming later in the trial will also be given that drug are increased. In practice, the allocation of treatment to a patient is determined by a computer algorithm, so the doctors running the trial remain blinded to who gets what.

A major gamble

Some trials combine both approaches, so that each arm in a platform trial tests in an adaptive fashion. One well-known trial that did things this way is the I-SPY2 trial. It was launched in 2010 by non-profit organisation the Quantum Leap Healthcare Collaborative to search for drugs that could prevent the progression of breast cancer, a common condition for which, at the time, there were few effective drugs. The trial tested six drugs simultaneously, using a single control group as the standard against which they were measured. Drugs that showed signs of efficacy would graduate for further evaluation and these would then become part of a new group of controls receiving the now-updated standard of care. I-SPY2 has enrolled more than 1400 participants and tested 16 drugs.

In a sense, I-SPY2 was a major gamble, says Scott Berry, a co-founder of Berry Consultants, who helped to set up the trial. At the time, the various agencies that approve drugs as safe for use were sceptical of adaptive trials and there was no guarantee that they would accept the evidence from I-SPY2 as valid.

But that has changed. In 2015, Janet Woodcock, who heads the US Food and Drug Administration (FDA), published an article in the *New England Journal of Medicine* that not only green-lighted novel designs, but actually encouraged them. She specifically cited I-SPY2 as an example of how adaptive and platform trials can successfully, quickly and safely identify promising therapies. This, says Ronenn Roubenoff at the pharmaceutical company Novartis, was a watershed moment. The FDA and the European Medicines Agency have now approved several drugs tested by the I-SPY2 programme.

Adaptive platform trials had been given a shot in the arm – and they were about to get another unexpected boost. In 2020, the covid-19 pandemic struck. Hospitals around the world were thrown into chaos and countries needed treatments, pronto.

One of the first and largest covid-19 platform trials was the UK's RECOVERY trial, led by Landray and his University of Oxford colleague Peter Horby. Beginning in March 2020, RECOVERY aimed to test whether widely available drugs reduce the chances of someone dying from covid-19. The study has since enrolled nearly 50,000 participants and tested 10 drugs, three of which have proved effective. Similar kinds of trial have cropped up elsewhere, including efforts from the team behind I-SPY2 and the TOGETHER Trial in Canada and Brazil.

For Landray, the pandemic has shown that clinical research doesn't have to stand apart from regular patient care. It can become an integral element of it in the form of adaptive trials. He points out that most medical practice isn't actually based on evidence. Even in cardiology, which has particularly rigorous

›

guidelines, only about a quarter of what doctors do has been supported by clinical trials. The biggest advantage of adaptive and platform trials, he believes, is their potential to shift clinical research away from large academic hubs and to smaller hospitals and surgeries. This would allow more physicians and patients to take part in studies.

Some doctors are nervous about these new kinds of trial. The statistical methods behind some of them can be arcane, which makes them difficult to replicate. If you don't have a PhD in statistics, study methods can seem like a black box, says William Rosenberger at George Mason University in Virginia. And while adaptive trials get results more quickly, they require more planning work and a large support staff to run.

Platform and adaptive trials also aren't suitable in all circumstances. For instance, if patients need to be followed for several years to determine a drug's efficacy, researchers might not be able to conduct the interim analyses needed to alter randomisation. Then there are orphan diseases, conditions that affect a very small number of people, and for which there aren't multiple new drugs available to test.

Still, spurred on by the pandemic, many doctors are now deciding to embrace adaptive trials. At Massachusetts General Hospital, neurologists Sabrina Paganoni and Merit Cudkowicz are looking for treatments for motor neurone disease, also known as amyotrophic lateral sclerosis, which robs patients of their ability to walk, talk, swallow and, ultimately, breathe.

With the HEALEY platform trial, which launched in 2020, they and their team are testing three drugs at once. With an adaptive platform design, they could get answers using only 480 participants instead of the 720 needed for a conventional clinical trial. Work on the first drugs is already wrapping up and two more are due to be added soon.

"We never could have gotten these answers with a standard design," says Paganoni. "And patients are relieved that they are much more likely to receive an actual treatment." ▮

Carrie Arnold is a science journalist based in Virginia

An early clinical trial showed that eating fresh fruit is an effective way to avoid scurvy

D3SIGN/GETTY IMAGES

Trials for everything

There are all sorts of things that might help people live better lives that fall outside the sphere of medicine, such as providing sanitation, solar panels or textbooks. Global development organisations often use randomised controlled trials (RCTs) to evaluate what kind of interventions are the most effective. But traditional RCTs are slow and expensive, so charities are increasingly interested in using novel trial designs (see main story).

Luke Allen at the London School of Hygiene & Tropical Medicine is working on several such trials. Prescription glasses improve vision and enable children to learn better in school, but in parts of Asia and Africa, many people who are prescribed glasses never get them fitted. Along with several partners, including UK charity Peek Vision, the University of Botswana and the Kenyan Ministry of Health, Allen and his colleagues are designing adaptive trials that will test a range of interventions that could help. These include tweaking the nature of reminder messages and offering incentives such as money-off vouchers. Variations of these interventions will be tested all at once and algorithms will tilt the balance towards more successful strategies as the trials go on.

Trials of any stripe must get ethical approval from review boards before going ahead, which can take months. For adaptive trials, where speed is of the essence, this can be a major barrier. Allen says faster ethical review processes could help the world's most disadvantaged communities benefit from adaptive trials. "They don't have time to waste," he says.

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JENNIE EDWARDS

'What we want to do is search intelligently'

We rely on space probes to explore the furthest reaches of our solar system and beyond. To succeed, we need to make them more curious, NASA's **Steve Chien** tells Neil Briscoe

HUMANS aren't well suited to long-duration space flight. We are too delicate, too heavy and we require far too many resources to keep us alive. When it comes to exploring our solar system and the worlds beyond that, it makes more sense to send machines.

Unfortunately, machines don't share our innate curiosity. A spacecraft designed to take pictures of the surface of a planet wouldn't be surprised if an alien suddenly scurried across the screen and switch its focus, it would just continue to take pictures of rocks. Steve Chien and his colleagues are trying to change that.

Chien heads up the department that looks after artificial intelligence during mission planning at NASA's Jet Propulsion Laboratory (JPL) – the birthplace of missions such as Voyager, which ventured to the edge of the solar system, and New Horizons, which flew by Pluto. In his day job, he creates software and systems that will allow deep space probes and planetary rovers – the likes of the Rosetta mission to a comet and Perseverance to ›

Mars – to better emulate the way humans think and act. He wants to turn spacecraft into true explorers, rather than just collections of cameras and sensors powered by a rocket motor.

When not working on space missions, Chien grapples with AI on Earth. He was recently a co-author on a US government report on the future of AI. The report found the US needs to reposition itself to become a leader in the field or experience the potential consequences of AI-based cyberattacks in the future.

Neil Briscoe: What is it like to work at the Jet Propulsion Laboratory?

Steve Chien: I am unusual at JPL in that I haven't dreamed of working there since I was a child. However, I've had the tremendous opportunity to work on a number of incredible missions, including the European Space Agency's Rosetta and currently the Mars 2020 Perseverance rover, and that's what has kept me so very interested in working at JPL. I've been honoured to work with such amazing scientists and engineers.

Do you have a favourite mission you have worked on?

It's hard to pick out a favourite. Certainly, Rosetta was incredible, for so many reasons. First and foremost, the people on the teams – the science team, the operations team – were incredible. It was amazing to see scientists from all of Europe, all of the world, coming together with this common goal of operating this spacecraft, of discovering the inner workings of comets and indeed our solar system. It was quite a rush to see the entire world become so engaged in the science.

What kind of intelligence does the Perseverance rover, currently exploring Mars, have? Is it a smart rover?

Well, smartness is a relative term. Perseverance can do much more than prior rovers, but it is still way behind what a human science and engineering team could do on Mars. For example, the rover can now, for certain instruments, "hunt for targets" given certain criteria such as colour, shape, distance from the rover. It will acquire wide field of view imagery, find targets within that which best match the criteria and then fire a laser to take a more detailed measurement.

Perseverance has more powerful navigation systems that allow it to drive faster and further, independently. But the progress is incremental and there's a long way to go. We are also working on software that will allow the Perseverance rover to adjust the plan sent from the ground [on Earth] in the event that activities are shorter or longer than anticipated, shuffling activities and adding and dropping activities to fit.

You have described your work as making space probes more curious. What do you mean by that?

The smarts we've been able to put on spacecraft and rovers thus far have been to recognise things we understand. To target specific types of rocks with a laser or to search for dust devils in a sequence of images, for example.

In the future, when we travel to the complete unknown, we will need to go beyond this. We'll need to look for patterns in data. For example, on Earth, we might look at overhead imagery and cluster it based on colour, texture, ruggedness and linear features. Based on these features, we might naturally discriminate between lakes, rivers, mountains, forests. But on another planet or moon, these might correspond to different types of sand dunes, oceans, vegetation and so on.

"The robots have to be smart enough to look on their own"

Why not send humans to investigate other planets and moons?

Humans are very sensitive, very fragile. Sending humans to low Earth orbit requires an amazing endeavour, to the moon required an enormous endeavour and sending them to Mars is even more challenging. And those are all places where we're certain there isn't life.

If you look within the solar system, there are several places where we believe there could be life. Basically, the strategy is to look for liquid water. One of the most promising places is Europa, a moon of Jupiter. You can't really send people there because the Jupiter radiation is very harsh, plus you need a very long mission to go there. So, we have to send robots to look for life. But because of the distances involved, the communication is very difficult. The robots have to be smart enough to look on their own.

Can AI make probes and rovers recognise things in the same way a human does?

There's a central question of how smart machines need to be that's poking at the edges of artificial general intelligence. And that's what people talk about when they think of characters such as Data from *Star Trek* – something that could interact at a peer level with humans on a broad spread of topics, just like a human could.

We don't really need that in space. What we need is a specialised intelligence. A smart spacecraft doesn't need to know how to take a bus in Dublin, or how to book a flight. It needs to know very specific things, such as how its sensors work. It needs to know about the science that people want it to do.

So, AI is a way of stepping beyond just a probe sticking to a checklist?

Already the robotic missions are somewhat running themselves, autonomously, but we're just scratching the surface of the possible. A great example is that fantastic mission called New Horizons, which was run by a colleague of mine, Alan Stern. They did some amazing

NASA/JPL-CALTECH/MSSS

NASA's 2020 Mars Perseverance rover uses AI navigation

things – flew by Pluto, flew by the Kuiper belt object Arrokoth and did some incredible science. But they pre-planned how they would fly by those places.

What we'd like in the future is for the spacecraft to be smarter and look for certain things. It would look for satellites, for moons and moonlets and if it finds them, would take extra images of them. Plumes, little geysers, are a remarkable scientific phenomenon, so again the spacecraft would know to take more and more images of those.

How can we equip probes with these sorts of abilities?

It seems like this would be very easy, that you'd just tell the software to do that. But it turns out it's actually really complicated. You have to know how the spacecraft is moving, how and where to point, and most of all the spacecraft has to understand that "that's a plume".

These are all things that humans do very well. We walk around the world, and we say "that's a chair" or "that's rain falling". But making computers understand these things is not so easy. When you talk about curiosity, and you talk about wonder, the first steps to that are being able to spot what's unusual, what's different.

What we want to do is search intelligently, and we do that with things we call white lists and black lists. A white list contains specific things you're looking for. It might include sulphur, because sulphur is a sign of life, for example. A black list is where you're expecting to see certain things, but if we see something else, something we weren't expecting to see, that's interesting. You search, you see all of the things you expect, but – whoa! – you spot something you weren't ready for, like maybe a Martian runs past the lens. That is the big step towards intelligent curiosity – recognising that which is unusual and exciting.

How is your work with AI in space relevant down here on Earth?

I had the honour of supporting a congressional report on the role of AI in national security. In cyber, one can create hundreds or thousands of software agents far more easily than building physical tanks, airplanes, ships or missiles. By software agents I mean programs that allow hackers to take over computers and launch attacks from a myriad of hosts across the internet.

They are getting smarter and more complex every day. It is a global software arms race, with many advantages to the attacker. The defender needs to win all the time. The attacker only needs to win some of the time to succeed. The differentiating factor is speed and smarts derived from AI. Whoever has the smartest agents will win the cyberwar and whoever wins the AI competition will dominate cyberspace.

In today's world, everything is controlled by computers – power, water, communications, transportation – hence the importance of AI to nations. Cybersecurity is incredibly important to space missions too, as we use computers to plan out and operate these extremely complex missions. Any cyberthreat could jeopardise the entire mission.

My core expertise is AI as it relates to space, which is an important and large area. But AI, while certainly not the same across all applications, does share quite a bit of commonality. A lot of the report focuses on general issues, such as the challenges to AI research, deployment of AI, training workforces and global cooperation.

How far away are we from an artificially intelligent probe that can truly make discoveries in the same way that humans do?

This is a very tough question. Already, there are machine-enabled discoveries being made every day. In these cases, the AI is amplifying the human intelligence, enabling the combined team to consider more plans, to find better plans.

Humans have a better strategic view, and the computer can run down leads and search, taking high-level direction from humans. A machine making an independent discovery? This is far less common. But there are cases, typically where the human grasp of the problem is limited by huge amounts of data. Even in these cases, the human driven math and objective functions are a key part of the process.

As far as human-level competence in human-dominated fields, I do not see that in the near future, say in the next five or so years. But the pace of progress is astounding in some areas. I am unwilling to make any projections beyond five-to-10 years, which makes me sound like an economist! ▮

Neil Briscoe is a freelance writer based in Belfast, UK

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Puzzles
Try our crossword, quick quiz and logic puzzle p53

***Almost* the last word**
Do frogs notice when it is raining? Our readers respond p54

Tom Gauld for *New Scientist*
A cartoonist's take on the world p55

Feedback
Cryptocurrency trading via hamster: the week in weird p56

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p56

The science of cooking

A lot of hot air

A soufflé that rises isn't exactly rocket science, but you do need to obey the laws of physics, says **Sam Wong**

Sam Wong is social media editor and self-appointed chief gourmand at *New Scientist*. Follow him @samwong1

What you need

2 ripe bananas
2 eggs plus 2 egg whites
60g caster sugar
Lemon juice
Salt
Butter

The science of cooking appears every four weeks

Next week

Stargazing at home

SOUFFLÉS have a reputation for being perilous, but they aren't nearly as challenging as many people will have you believe. In fact, as long as you have a mixture full of air bubbles, the laws of physics dictate that it must rise when it is heated.

The relevant principle is described by Charles's law, named after the French scientist Jacques Charles, who was also a pioneer of balloon flight. It states that the volume of a gas is proportional to its temperature.

That means the bubbles in a soufflé mixture expand when they are heated, but this only accounts for about a quarter of the rise. Heating also causes water in the mixture to evaporate, which adds to the amount of gas in the bubbles.

These two processes should reliably ensure that a soufflé rises, and the hotter the oven, the quicker and bigger the rise. The flip side – and the bane of many a dinner-party chef – is that a soufflé will inevitably start to sink as soon as it comes out of the oven. The only way around this is to serve it straight away. A fallen soufflé will rise again if returned to the oven, although not to its original height.

The structure that holds the gases comes from egg whites that have been whisked until stiff, producing a stable foam. This is the result of globular proteins in the egg unfolding when beaten, then bonding together to create a rigid framework that stabilises the bubbles. Aquafaba, the liquid drained from a tin of chickpeas, can be used as a vegan substitute as it contains some of the same proteins found in eggs. Sugar and acid help to increase the stability of the foam.

GMVOZD/GETTY IMAGES

Hervé This, author of *Molecular Gastronomy*, recommends placing a soufflé at the bottom of the oven, so it is heated directly from below. If evaporation starts at the bottom of the ramekin, the bubbles lift the whole soufflé upwards. He also suggests putting the soufflé under a grill (broiler to North Americans) to seal the surface before baking it. This prevents bubbles at the top from bursting, thereby keeping more of the gas inside. In my experience, however, you can still get an impressive rise without doing this, so you might want to skip it to save time.

To make four banana soufflés, mash two ripe bananas with two egg yolks and a pinch of salt. In a separate bowl, whisk four egg whites with a tablespoon of lemon juice. When soft peaks form, gradually add 60 grams of sugar while continuing to whisk until the foam is stiff. Add a quarter of the foam to the banana mixture and stir vigorously to lighten it. Then slowly and gently fold in the rest of the foam with a spatula.

Spoon the mixture into four buttered ramekins and bake at 200°C for about 15 minutes, or until well risen and brown on top. Serve immediately with sugared nuts, caramel sauce or ice cream. Or why not add all three? ▮

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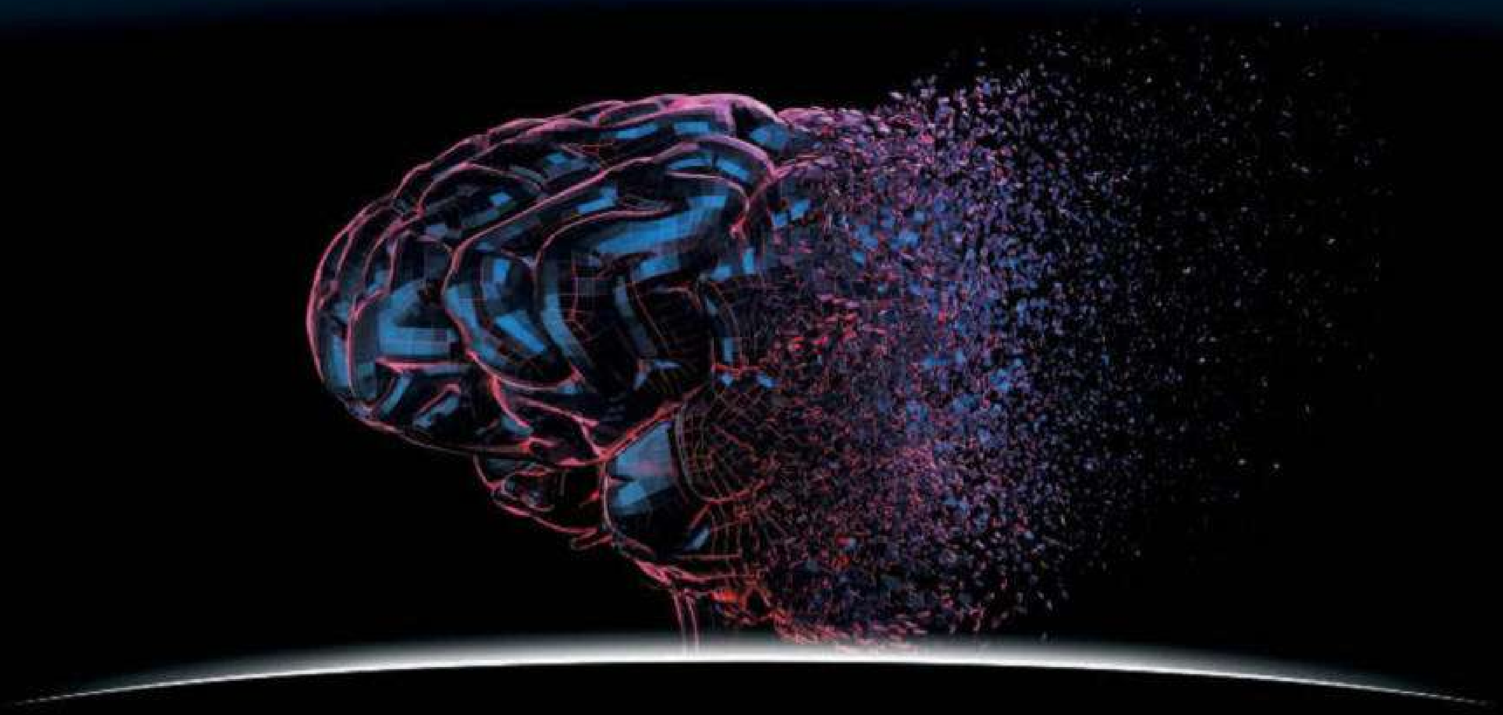

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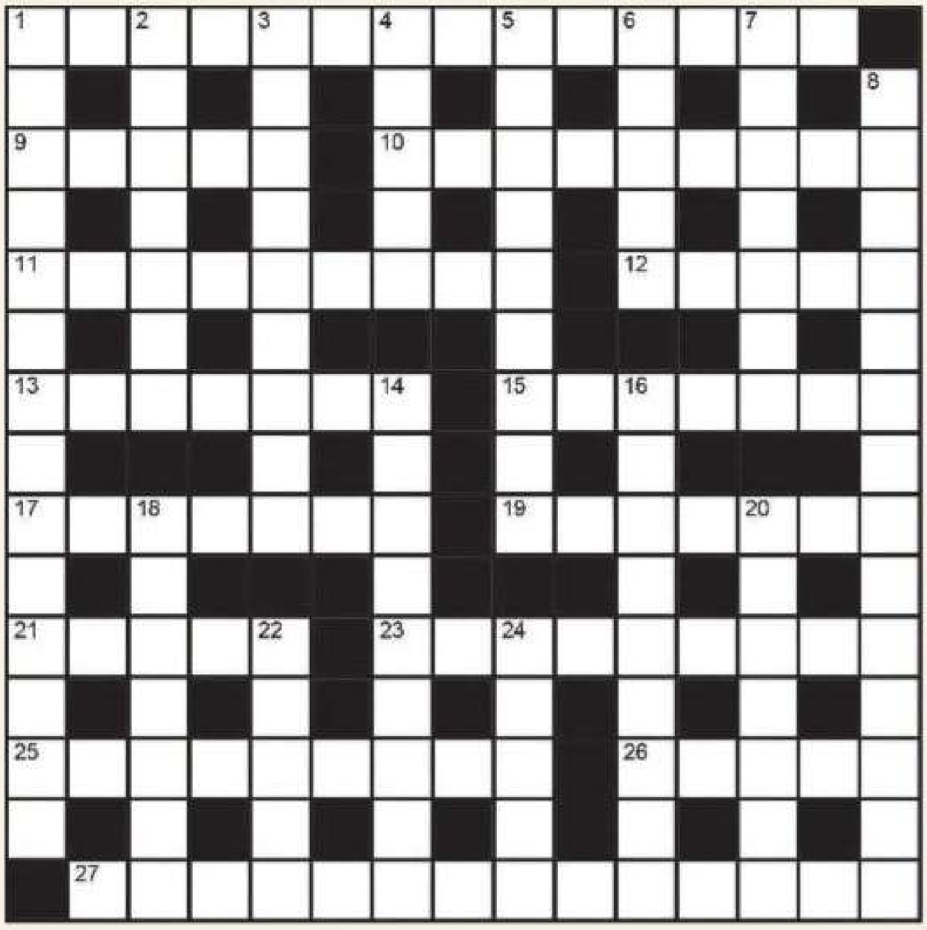
Quick crossword #94 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Means of preserving produce such as milk or wine (14)
9 O_3 (5)
10 Remove O from (9)
11 Surgical procedure (9)
12 US television medical drama, first broadcast in 2004 (5)
13 Yt (7)
15 Resistance of an object to change in velocity (7)
17 Ocean liner sunk in 1912 (7)
19 Portable computers (7)
21 Turn inside out (5)
23 Optometrist (3,6)
25 Fortified against disease, perhaps by a vaccine (9)
26 Organisms that share a regional climate, collectively (5)
27 1977 sci-fi novel by Philip K. Dick (1,7,6)

DOWN

1 Transformation of light into chemical energy (14)
2 Least fast (7)
3 Altitude; height (9)
4 Spokes (5)
5 Wading bird with a spatulate beak (9)
6 Upper part of the leg (5)
7 Channel known in humans as the Fallopian tube (7)
8 Specialism focusing on the contents of the abdomen (7,7)
14 A. A. ___, US physicist known for measuring the speed of light (9)
16 Spurge (9)
18 Vacuum flask (7)
20 Microsoft email software (7)
22 US producer of toy trucks (5)
24 Berry bearing shrub in the genus *Sambucus* (5)

Our crosswords are now solvable online
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Quick quiz #124

1 Who was the first woman awarded the Fields medal, the most prestigious honour in mathematics?

2 The three layers of the wall of the human heart are the epicardium, the myocardium and what?

3 *Anopheles*, *Aedes* and *Culex* are genera of which type of creature?

4 Name the subatomic particle discovered by Carl David Anderson and Seth Neddermeyer in 1936.

5 Which is closer to the Milky Way, the Large Magellanic Cloud or Small Magellanic Cloud?

Answers on page 55

Puzzle

set by Katie Steckles

#136 Narrowing the spectrum

VECTORFX/SHUTTERSTOCK

Marie: "What's your favourite colour of the rainbow?"

Lise: "That would be telling... its name is made up only of letters that occur in the names of the other six colours of the rainbow."

Marie: "But there is more than one colour that rule works for!"

Lise: "Ah, but if you just look at the colours that fit that rule, it is the only one that can't be made from the letters in the other members of that set!"

What colour is it?

Solution next week

Croaking in the rain

Do frogs notice when it is raining?

John Owen-Jones
Stoke Canon, Devon, UK

In summer, my favourite party trick for visitors in the garden is to switch on the hose so it sprinkles over my pond. Within minutes, many frogs come out and enjoy the shower.

Sabrina Burmeister
University of North Carolina, US

The answer depends on what we mean by "notice".

There is good evidence that rain has a strong effect on the behaviour of frogs. It stimulates males to call and females to navigate to ponds, so they must "notice" changes in rainfall just as they "notice" changes in other aspects of their environment, such as shifts in temperature or the presence of predators or mates.

On the other hand, do the frogs "notice" the rain in the way you and I do, in that we reflect on the rain and the implications for our behaviour (thinking "hmm, it's raining, that means it is time to put on a raincoat")?

"The green tree frogs in our yard respond to rumbling noises that resemble the sound of thunder and start to vocalise"

Because frogs can't talk, we will never really know the answer, but we can speculate. While frogs do express a wide range of fascinating behaviours, the ability to reflect isn't required to explain them. Their brains are also relatively simple compared with those of animals such as birds and mammals, whose decision-making seems to be more complex.

Carol Petherick
Cawarral, Queensland, Australia

We can tell whether other animals "notice" something if they respond to it by changing their behaviour.

Here in the dry tropics of Queensland, rainfall tends to coincide with increasing temperatures and day length. I can't say that the many dozens of frogs we have in our yard definitely notice when it is raining, but they do appear to respond to increased humidity and, even if it isn't raining, they will start to croak and become more active.

Interestingly, green tree frogs vocalise if we are watering in their vicinity even though they aren't getting wet, and also in response to rumbling noises that even vaguely resemble the sound of thunder. This suggests that they are responding to rain-associated noises.

When it does rain, we see frogs leaping through vegetation and across the grass and roads, particularly at night.

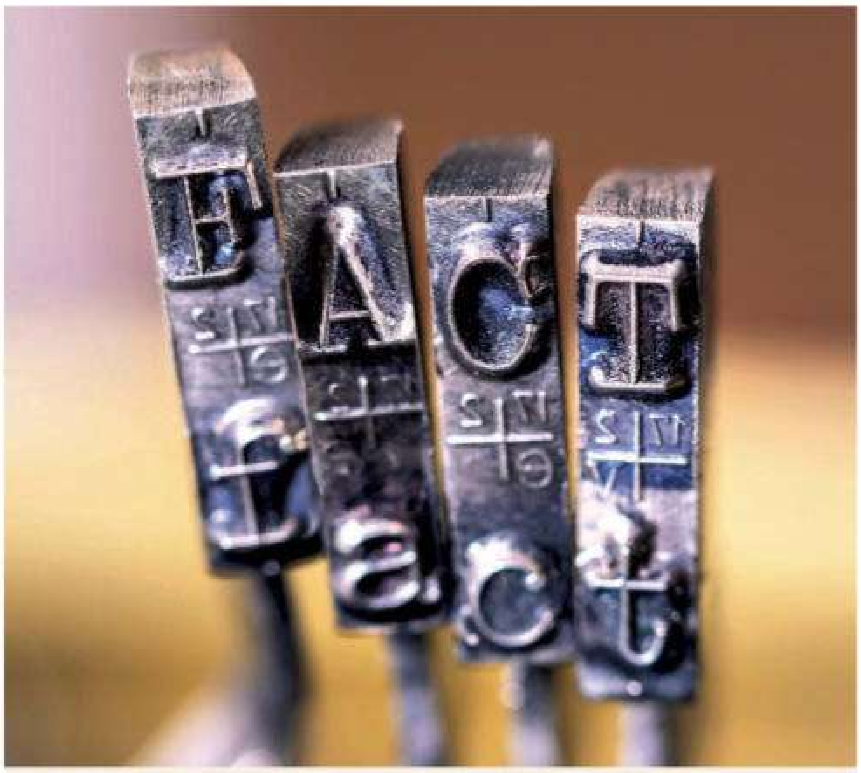
Unfortunately, many get squashed by vehicles.

Lyndal Thorburn
Greenleigh, New South Wales, Australia

Our semi-rural property has a dam that is home to eight species of frog. They certainly know when it has been raining.

Last week, we had a short, sharp storm. Afterwards, the number of frogs calling increased.

I am sorry now that I didn't count them so I could provide definitive "before and after" statistics, but we often comment on the frogs starting up calling again after a rain shower (as long as the air temperature is more than 4°C – below this, they stop calling altogether).



PILLIP/ALAMY

At what point is a theory accepted to be correct, and who makes that call?

This week's new questions

On the boil **When cooking, what difference does it make if the water is simmering or boiling vigorously, given that water boils at 100 degrees?** ***Raffi Katz****, Watford, Hertfordshire, UK*

Factual evolution **When does a theory become a fact, and who decides?** ***Dave Reidon****, Broadwater, Queensland, Australia*

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Dying to be green

Indestructible coffins aside, what is the most environmentally friendly way to deal with our bodies after death? Is burial better than cremation?

Georgina Skipper
Weymouth, Dorset, UK

The question of the most eco-friendly burial has troubled me for years, as cremation seems little better than taking up acres with rows of rarely visited headstones. Woodland burial sites seem like the way to go. You still take up space, but with a tree rather than a headstone, and you have the post-death satisfaction of feeding the woodland and meadow.

Margaret Pitcher
Canberra, Australia

The most efficient way to get rid of a body once the "owner" no longer needs it would be to move it to the nearest patch of countryside and leave it out for the residents to recycle.

Since that option would be illegal in most parts of the world, I personally intend to take the most useful option I can find and will donate my body to a medical school. In other places, I would also have the option of leaving it to a body farm, a research facility for the study of decomposition. This choice means that I will continue to advance medical research and the training of doctors.

Rob Colebrook
Ludlow, Shropshire, UK

As far as I can see, the most environmentally friendly way to dispose of dead bodies is to transport them using a solar-powered hearse to an out-of-the-way area and let nature take its course. After a year or so, any bits that haven't been decomposed by microorganisms or scavenged by carrion-eating vertebrates can be transferred into lorries powered

Tom Gauld

for New Scientist

ANOTHER FRUSTRATINGLY NEAR MISS IN THE PROFESSOR'S LIFELONG SEARCH FOR THE RARE AND ELUSIVE URBAN SQUID.

by hydrogen fuel cells and deposited in the sea to feed fish.

Helen Gould

Saratoga, New South Wales, Australia

My husband is a co-editor of the book *Biochar for Environmental Management* and says the best way to dispose of dead bodies is to pyrolyse them and turn them into charcoal. That is what I want to happen to my corpse.

I hope that, after my funeral, when my biocharred body has cooled down, my friends will take some charcoal home to use in their gardens. The biochar will help draw down carbon from the atmosphere and build soil health.

> **"I want my corpse to be turned into charcoal. After my funeral, I hope my friends will take some home to use in their gardens"**

Mike Follows

Sutton Coldfield, West Midlands, UK

Each cremation releases about 200 kilograms of carbon into the atmosphere. A life cycle assessment of a Dutch funeral business showed that the environmental impact of a traditional burial is about 25 per cent smaller than that of cremation. However, once other factors like maintenance of the graveyard are taken into account, the impact of a burial is about 30 per cent larger than that of cremation. The analysis also found that the environmental impact of a funeral is typically three times larger than that of the burial itself, principally due to mourners travelling to the service.

Alternatively, there is flameless cremation via a process called alkaline hydrolysis, where the body is placed in a vessel like an oversized pressure cooker that contains potassium hydroxide. It is heated to about 160°C, but pressurised to prevent boiling. Within a few hours, the body is broken down into its chemical components and the liquid can be drained off and used as fertiliser. It requires about a quarter of the energy of flame-based cremation.

Stephen Johnson

Eugene, Oregon, US

Burial and cremation both have significant environmental costs. Burial may include the use of embalming chemicals and the appropriation of large amounts of land. In the US, more than 4000 square kilometres of land is devoted to cemeteries. Cremation requires furnaces that are often powered by fossil fuels, and it emits carbon monoxide, heavy metals, sulphur dioxide and mercury.

In some places, including Oregon, a recently legalised option is high-temperature composting. This uses wood chips, alfafa and straw as the composting medium. It takes about five weeks and creates a cubic metre of soil that can be used for gardening. All parts of the body are used. Each body composted saves a metric tonne of carbon dioxide from being released compared with burial or cremation. ▮

Answers

Quick quiz #124
Answers

1 Maryam Mirzakhani in 2014
2 The endocardium
3 Mosquito
4 The muon
5 The Large Magellanic Cloud, by around 40,000 light years

Cryptic crossword #68 *Answers*

ACROSS 1 Soho, **3** Marmoset, **9** Airmail, **10** Taxon, **11** Dazed, **12** Orchid, **14** Edible, **16** Move in, **18** Heroic, **19** Decal, **22** Leapt, **23** Exiting, **24** Gossamer, **25** Skye

DOWN 1 Swaddled, **2** Hertz, **4** Abloom, **5** Mitochondria, **6** Sex life, **7** Tang, **8** Dandelion tea, **13** Analogue, **15** Ice caps, **17** Scheme, **20** Crick, **21** Slug

#135 You don't know jackpot
Solution

The jackpot setting is Cherry, 7, Cherry. Playing five times means the woman spent $2.50. Since she says that the "house always wins", we know she didn't win any more than $2. We also know the new jackpot setting doesn't end in a seven or have two or more sevens, since I didn't win anything when I got three sevens. Every remaining jackpot setting would have won $3 or more, except Cherry, 7, Cherry, which would have only won $2.

Animal spirits

Feedback's heart is much warmed by the tale of a live-streamed hamster called Mr Goxx who has, according to a report in *Business Insider*, been trading a portfolio of cryptocurrencies by running round and round an "intention wheel" and scurrying down one of two tunnels to determine whether to buy or sell.

Apparently, Mr Goxx has significantly outperformed the US S&P 500 stock index. Feedback isn't surprised: after all, John Maynard Keynes coined the term "animal spirits" to describe how humans arrive at financial decisions. At least the hamster provides a more wieldy predictor than the team of 10 reindeer who, as we reported earlier this year (9 January), were also outperforming the S&P.

We would welcome immediate investigations of the market investment strategies of actual bulls and bears, if only for the challenge of the experimental design and possibly the subsequent spectator sport. Meanwhile, if anyone asks why we are reporting the hamster story a month late, it's because we found it while shredding some of our extensive piles of paper for our own decision cage. Our hunch is that squirrels will have a strong instinct where to put our money.

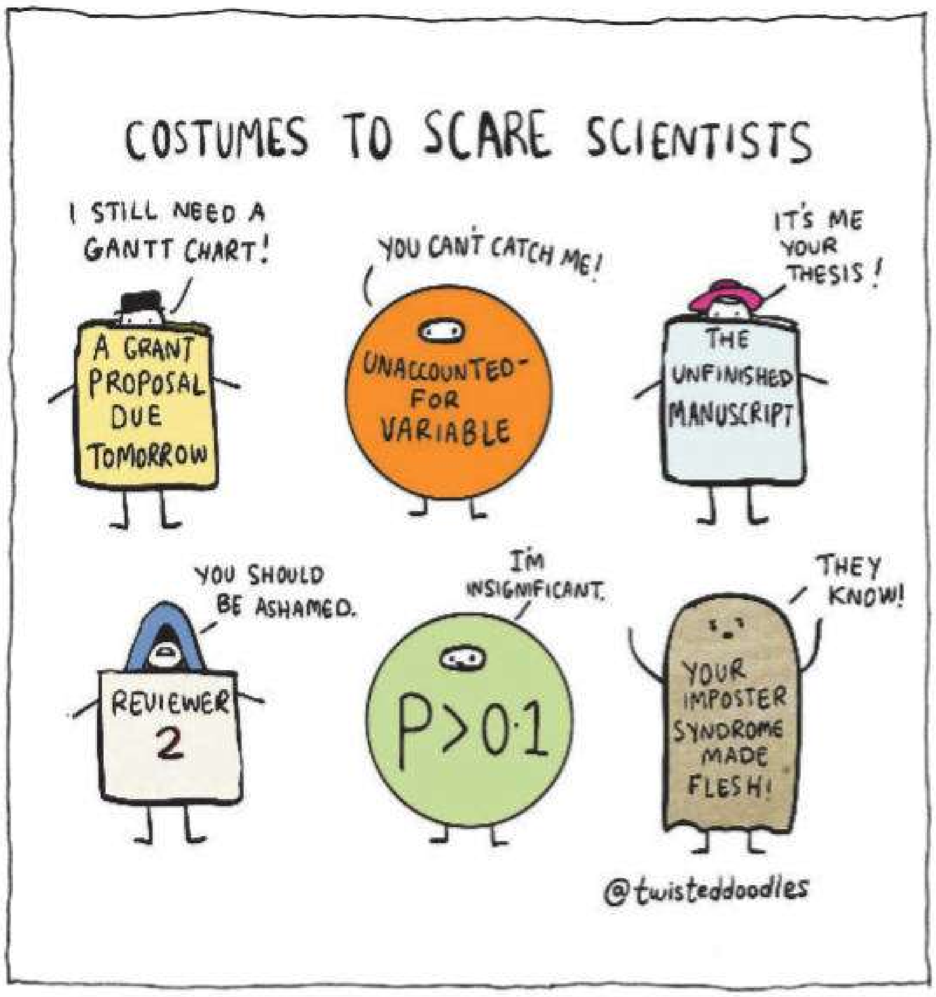
Gettin' jiggy wit it

Speaking of spectator sports, much time, money, energy and chemical know-how has flowed into elite athletes to enable them to squeeze out every last drop of additional performance. Feedback can only give kudos, and possibly medals, to Seung-Taek Lim at the Kangwon National University Olympic Studies Center in South Korea and their colleagues, who ran at this question from an entirely new angle.

In their new paper "The effect of whole body vibration on the sprint ability of Korean national bobsled and skeleton athletes", they study the effect of giving elite competitors a good old jiggling about at a frequency of 30 hertz before they set off. The team found a significant improvement in sprint times.

We look forward to the staid warm-up routines of elite athletes taking on a distinctly more agitated air. Come to think of it, with the 100 metres lasting mere seconds, let's make the warm-ups the main competitive event.

Twisteddoodles *for New Scientist*


COSTUMES TO SCARE SCIENTISTS
I STILL NEED A GANTT CHART!
A GRANT PROPOSAL DUE TOMORROW
YOU CAN'T CATCH ME!
UNACCOUNTED-FOR VARIABLE
IT'S ME YOUR THESIS!
THE UNFINISHED MANUSCRIPT
YOU SHOULD BE ASHAMED.
REVIEWER 2
I'M INSIGNIFICANT.
P>0·1
THEY KNOW!
YOUR IMPOSTER SYNDROME MADE FLESH!
@twisteddoodles

Got a story for Feedback?

Send it to feedback@newscientist.com or New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT

Consideration of items sent in the post will be delayed

Cold hard stare

Many thanks for your responses on the mysterious yet understudied male inability to find objects in the fridge (9 October). In general, we agree that neuroscience has exploded the myth of differing female and male brains, but we are left wondering in this instance if there is a question to answer.

Graham Revill from Clachaig in Argyll and Bute, UK, goes so far as to say that in his home a cursory glance and cry of "It's been moved" is known as a "Boy Look", while the subsequent efficient and successful search by a female member of the household is known as a "Girl Look". Simon Durk, meanwhile, speculates that the phenomenon is object-specific, being less pronounced in the case of, say, cold beer. He also points to a related effect, "more common among older males", of a sought item not turning up at the place it actually is until the third time of looking. Science: your services are called upon.

It is what it isn't

More metaphysical conundrums of Feedback's favourite type as Adrian Smith points us to University of Leeds professor Samantha Pugh's tweet about a room at that august institution whose door is marked with a brass nameplate reading "Unnamed room".

Meanwhile, David Pringle shares a screenshot of a page at the Australian government's Department of Veterans' Affairs website. "Sorry, this page doesn't exist", it says, adding by way of a footnote that this information was last updated on 23 September 2019. Underneath, David is invited to click yes or no to the question: "Was this page useful?"

Quite possibly it was useful, David, at least until September 2019. Useful in much the same way that the blue heritage plaque Feedback sometimes passes on an otherwise undistinguished London railway bridge is useful. It reads simply: "This plaque was installed 6th May 2010". Mind you, we think that one might be art.

Alien thinking

A colleague is startled to receive a press release with the subject line "Mars calls for credible net zero targets which are 'fit for purpose'". Discounting, as is traditional, mundane terrestrial explanations for this phenomenon, it is clear that interplanetary pressure is building ahead of the crucial COP26 climate summit (see page 36). Perhaps the intervention would have carried more weight coming from Venus, where the deleterious consequences of a runaway greenhouse effect (see page 18) are all too plain.

Best buddies

Perusing the safety warnings for a new set of earbuds – "as you do" – Lindsay Wright from Rangiora in New Zealand was surprised to read the injunction to "not install the appliance in a confined space, such as a bookcase or built-in cabinet".

What disaster might befall the unwary isn't elaborated upon. We much appreciate the concern you express for our well-being, Lindsay, constrained as we are in our stationery-cupboard quarters. If you don't hear from us next week, either the earbuds got us or the squirrels turned nasty. ▮

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